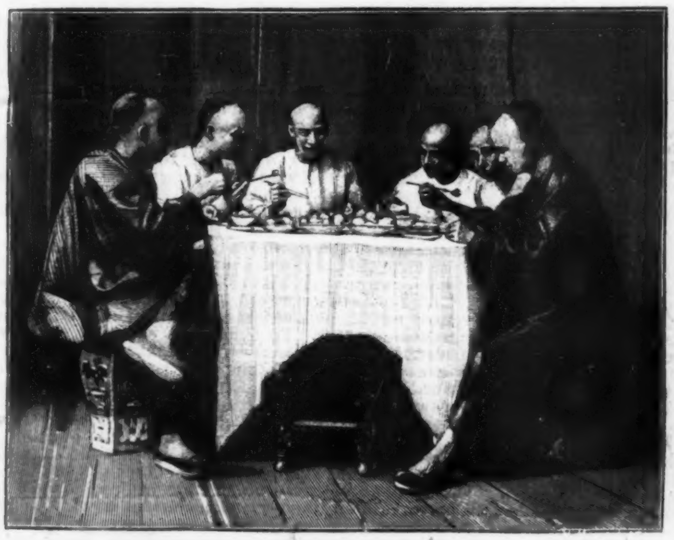
SCIENTIFIC AMERICAN SUPPLEMENT. No 1162

Scientific American, established 1845.
Scientific American Supplement. Vol. XLV. No. 1162

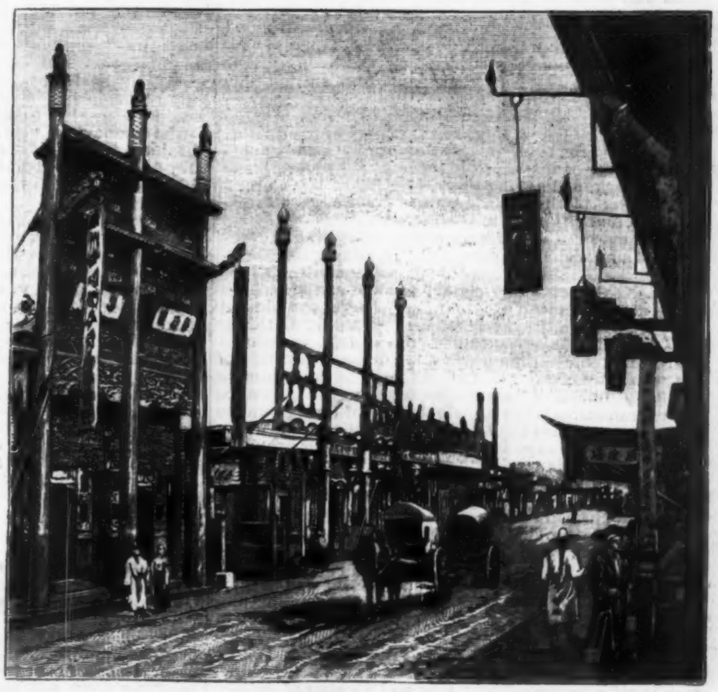
NEW YORK, APRIL 9, 1898.

Scientific American Supplement. $5 a year.
Scientific American and Supplement. $7 a year.

THE CHINESE WALL NEAR KULDSCHA.



A DINNER PARTY.



A STREET IN PEKING.

ACTORS IN STAGE COSTUME.

THE HARBOR OF CHEMULPO.

SCENES IN CHINA.

CHINESE GOVERNMENT OFFICIALS.

A Chinese mandarin, a judge, ordered a goldsmith to procure two bars of gold for him. The goldsmith complied with his request, brought the bars of gold to the judge, and the latter asked their cost.

"There is a fixed price for gold,' replied the vendor, "a price which everyone knows. But from you, honored lord, I will demand only one-half the customary price."

"Good," said the mandarin, giving back a bar to the goldsmith, "I will keep but one and return the other to you. I therefore owe you nothing."

"But—" answered the vendor. Before he could continue, the mandarin angrily interrupted him:

"You have without haggling obtained your own price from me, and still you complain? Off with you, or I will have you cast into jail!"

This anecdote, taken from a Chinese paper, gives an excellent picture of the mandarin in particular, and of Chinese officials in general. In every-day life the mandarin appears exactly as here described,—greedy, deceitful and extortionate.

Theoretically the official is of course a totally different person. According to Chinese law, only the most distinguished scholars are supposed to fill governmental positions; but in China, more than in any other part of the world, theory and practice contradict each other. Let us see how this contradiction originated, at the same time describing the career of a Chinese mandarin from the very beginning.

Whoever desires to become a mandarin must, above all, have passed the first civil service examination; otherwise, he cannot be appointed to the most insignificant position. Before we proceed it must be distinctly understood that the name "mandarin" is by no means applied to a government official by the Chinese. The name was invented by the Portuguese, who were the first to have any relations with the Orient. The rank of an official in China is designated by the word "kwum," and if in spite of this we have retained the title "mandarin," it is because the word is more familiar to Europeans.

Whoever desires to pass the civil service examinations must naturally have acquired a certain amount of knowledge. In all China there are no public schools in our sense of the word, but in their place we find private schools, where the children of the cultured learn how to draw on paper and how to read a few thousand Chinese characters, besides receiving religious instruction. Of the exact sciences as they are taught in our schools, nothing whatever is said.

Geography, history and foreign languages are unknown. Of what is going on in the world of discoveries or inventions, not a word is mentioned. When the pupils have graduated from these private schools, those who desire to pass the civil service examination enter another school in which the actual preparation begins. These higher preparatory schools are attended not always by children, but more often by men of mature age, who have earned only by a life of toil the money necessary to defray the expense of tuition. In this second school all periods of life are represented, from boyhood to old age. Here instruction is given only in the history of literature. The Chinese, whose history extends back many thousand years, have a great number of distinguished poets and philosophers who are reckoned among the "classics" of the nation. The writings of these classics must be learned entirely by heart, and the pupil must be able to describe every passage, every shade of expression, every simile, every figure of speech. The entire course of instruction therefore consists in memorizing works of ancient authors which have no relation whatever to our own times. This accounts for the fearful ignorance of even the highest officials and most distinguished men regarding all things not Chinese. If even the cultured and most prominent men are absolutely ignorant of occurrences outside of China, what a condition of affairs must there be among the many millions of the lower classes! But the ignorance of the mandarins is the principal cause of the ignorance of the masses, since the latter firmly believe all the assertions of their superiors. They believe, for example, that the Christian religion requires its adherents to boil little children and to press oil from their bodies. These absurdities, disseminated by means of placards and pamphlets, are perhaps believed by the mandarins themselves. Publications of this character always result in a massacre either of missionaries or of native converts.

If the pupil considers himself sufficiently well prepared in the classics to subject himself to an examination, he enters his name for the next examination, which always takes place in the capital of the district. These examinations occur twice every three years, and thousands of candidates enter their names. The examination itself is comparatively easy and consists of written work only. The examiners, who must themselves have attained the highest degree of knowledge, read the thousands of papers which have been handed in, and finally select one-tenth of them as the best performances. Those who have been fortunate enough to have had their papers selected as the best, receive the title "Sin-tsai," or "budding genius," and with it the privilege of preparing themselves for a second examination. Although only one-tenth of the applicants can possibly pass, the others are by no means discouraged. They again enter the preparatory school, even though it be for the twentieth or thirtieth time. It is said that son, father and grandfather sometimes enter their names for the first examination. The second examination takes place in the capital of the province every three years, and is attended by all the prominent men of the province; the examiners on this occasion are specially appointed by the Emperor.

In every provincial capital there is usually outside the city a huge square surrounded by a high wall. The only openings are two gates placed opposite each other and connected by a passage which divides the square into two equal parts. On both sides of this passage are built long narrow structures like stalls, which extend to the very walls, and so close are they to one another that only an alley two paces in width separates two such long rows of sheds. Each shed is again partitioned into cells which number 12,000 to 14,000 in a single square. Each is provided with a door into which an opening has been cut, admitting light and air. Into such a cell the candidate is thrust. The cells are moreover provided with two boards, one upon which the candidate sits, the other upon which he writes. Beds, food and clothing are brought, for no one is permitted to leave the cells during the first three days. Each inmate receives written directions, and usually the little red papers which are handed to the candidates contain four themes, upon three of which a prose essay must be written, and upon the third, a poem. No manuscript can contain more than four hundred and less than three hundred characters. Only a very limited number of corrections are permitted. After three days have elapsed, the manuscripts are collected and the candidates allowed to sleep for a night without the square. Then they are again locked up for three days, and during this period they must complete five tasks. Mentally and physically, these six days are so fatiguing that very often candidates, particularly old men, die from exhaustion and over-exertion.

Theoretically all precautionary measures have been taken for the prevention of cheating and the formation of agreements among the candidates to assist one another. Walking up and down the alleys are men appointed to watch the candidates, but, like every one in China, they may be easily bribed. The regulations for the examination of papers are unusually strict and comprehensive and are couched in such terms that a candidate can be neither defrauded nor favored as far as his actual work is concerned. The contrary, nevertheless, does happen, and by bribery a candidate who has handed in a poor paper can outstrip a man whose work is excellent, but who has offered nothing to the examiners. If the applicant is the son of a prominent man, many of his faults will be overlooked, even though his work is worthless. All papers are carefully selected by the examiners, or at least a pretense is made in that direction. Of the great number of candidates examined, only a small number can pass the examination, since to every province only a certain number of offices are allotted. In the first examination only one hundred out of one thousand applicants can pass, but in the second examination only ten out of a thousand can come out of the ordeal unscathed, since only that number of diplomas are distributed. Those who, justly or unjustly, have been fortunate enough to pass the examination receive the title "Chiid-schiw," or "promoted man," while those who have failed immediately enter their names for the next examination. But the latter must wait one or two years, according to the quality of the work handed in, before they can attempt the next examination. The privilege of applying for a position, if a vacancy exists, is accorded to those who have passed the examination. Years may elapse, aye, tens of years, before the candidate is appointed to a position. If he has passed the third examination, by which he becomes a "Tsen-tse," or "finished scholar," he is more rapidly advanced. This third examination takes place in Peking itself every three years, in the spring of the year immediately following the province examinations. A concession is granted to the candidates in so far as the government bears the expense of their sojourn in the capital; but they must undertake at their own cost the journey from their native provinces,—a journey often very long and tedious, the expense of which most candidates would be unable to bear, were it not that they borrowed money at usurious interest. The funds thus obtained the borrowers hope to pay back as soon as they have been appointed to a position which will enable them to enrich themselves by extortion, cheating and robbery.

The candidates who have passed the third examination are naturally more rapidly advanced than those who have only gone through the first two. But, irrespective of the number of examinations passed, each candidate must begin at the ninth or lowest rank. In the civil government, as well as in the army and navy, there are nine ranks or grades, each symbolized by a particular animal form. In the civil government the ninth class is represented by the magpie, and the other classes proceeding upward by the quail, the duck, the heron, the silver pheasant, the wild goose, the peacock, the golden pheasant and the crane. The symbolical animal of each rank is embroidered in bright silk thread on a piece of silk about a foot square, and is worn on the breast and back of the official's dress. In the army and navy the ranks, beginning with the ninth class, are represented by the single-horned rhinoceros, the seal, the raccoon, the jaguar, the bear, the tiger, the leopard, the lion and the double-horned rhinoceros.

Chinese laws have established certain well defined principles to be followed in the appointment of officials. Of those who have passed the examinations, only they who are members of honorable castes can fill positions. For example, the sons, grandsons and great-grandsons of barbers, actors and sailors are dishonorable and can never become mandarins. In order that relatives may not be favored, no mandarin may be appointed to fill a position in his native district. He is not allowed to marry a woman beneath him in rank, and alliances with dancers, actresses and singers are sternly forbidden, not only to him, but also to his sons and grandsons. The mandarin must be diligent, must in all circumstances act with impartiality, and must never be a judge in a case in which even a relative of a distant relative of his wife is concerned. He must lead a faultless life, must conduct himself as a man of honor both in public and private life; he must be incorruptible, care for the good of his inferiors and carry out the commands of his superiors and those of the Emperor with the utmost promptness and rigor. For all this a salary is promised which increases considerably as he advances in rank. A mandarin of the ninth rank receives only an annual salary of about one hundred dollars, but then, as everyone knows, the necessities of life are ridiculously cheap in China. The salaries of the several ranks vary from one hundred dollars to fifteen thousand dollars, the salary paid, or rather promised, to the officials of the first rank. Salaries are paid very irregularly and in many cases not at all. The mandarins, who receive from the government the money to be paid to their subordinates, usually pocket the larger portion of these sums and pay out only a very small part of the money which their assistants ought to receive. But the official, it must be remembered, is in debt owing to the expense of his examination, and he must, moreover, bribe the officials in the capital of the district, in the capital of the province, and, above all, those in Peking. Under these circumstances the mandarin must, of necessity, become a cheat and a rascal. He appropriates incoming money and, above all, the fines which he imposes. He allows himself to be bribed, he cheats, he extorts, he exacts far heavier taxes than the government demands. Thus he gradually acquires a fortune, is appointed to higher offices and becomes a man of some consequence.

During the last ten years the government has been hard pressed for money, and for that reason offices have been generally sold. The appointments thus procured were generally used for the purpose of obtaining money by dishonorable means. Formerly appointments could be bought only by those who had passed the second civil service examination, and then only for very high prices; but recently it has been decided to sell offices to the wealthy without any requirement but the payment of a liberal sum of money. Men who resort to this means of procuring positions are, of course, the very ones to regain by usury and extortion what they have paid out. These are the men who are so averse to all innovations; for they know full well that, as soon as conditions are introduced which in any way resemble those of Europe, that as soon as China is opened to civilization, their offices will be lost and with them the prospect of purchasing still higher and more lucrative positions. Other mandarins fear that as soon as another system is introduced something more than a knowledge of ancient classics will be required of government officers; that then only men of modern culture will receive appointments and that those who are now in office will be discharged. For these reasons most mandarins, especially those of the provinces, are decided opponents of all innovations and deadly enemies of all foreigners. Even though the government were actuated by the best motives for the welfare of the country, and the Emperor should try to open China to European civilization, the mandarins would offer both passive and active resistance. They fear for the future of their children, for their relatives and for themselves, and they urge on the people against all strangers, be they missionaries or only merchants.

The mandarin when in office may receive honors without being necessarily promoted to a higher position. Thus, for example, the honor of wearing a crow's feather may be conferred upon him. Instead of a crow's feather he may be presented with a peacock's feather containing one, two or three eyes. These feathers are worn in a black cap which resembles a European military cap of large diameter at the top and without a peak. The highest honor which can be conferred upon a mandarin is the presentation of the yellow silk jacket, which must be worn at court, on journeys and in public. Besides the yellow jacket (yellow being the imperial and sacred color of the Chinese), the mandarin may also receive a little three cornered yellow flag which must be carried in the right hand during all official transactions and during visits at court. That little yellow flag is not as insignificant as might at first be supposed, for it gives to the bearer the right of life and death over all Chinese beneath him in rank. On that account there are in all China only three or four men who have received the high honor of carrying the little yellow flag. China also possesses one order, that of the double dragon, but the honor of wearing it is conferred only upon foreigners. Not as distinctions of rank, but merely as favors to the mandarins are granted the privileges of wearing yellow sword sheaths, of having red poles attached to their litters, and finally of wearing sable-fur on their clothing. A mandarin must never walk. He must either be borne in a litter, in which case he requires only four men; or else he must ride, and must then be escorted by at least ten men, two grooms riding before him and eight secretaries and clerks behind. Each mandarin has a great number of dependents whose salaries he must pay out of his own pocket. For reasons of economy, the government appoints entirely too few mandarins, and if the honest officials—and there are such, even though exceedingly rare—were to work themselves to death, they would never get through the amount of business which has accumulated. For this reason mandarins must engage secretaries and assistants at their own cost, and these, naturally following the example of their masters, steal, cheat and extort.

As long as there are mandarins, as long as officials are required merely to memorize ancient classics, China will be badly governed. Never will European culture and civilization, industry and trade be introduced, if the opposition of the mandarins cannot be overcome, if this corrupt official class cannot be crushed.—A. Oskar Klaussmann, in Ueber Land und Meer.

TRADE OF SPAIN IN 1897.

The Madrid correspondent of The London Times writes to his paper as follows: "The Imperial publishes a résumé of Spanish trade for last year, from which it appears that the imports amounted to 793,341,121 pesetas, as compared with 748,986,377 pesetas in 1896 and 703,792,244 pesetas in 1895. The exports were of the value of 924,936,047 pesetas, as against 892,328,618 pesetas in 1896 and 692,635,935 pesetas in 1895. The exports of last year exceeded, therefore, the imports by 131,594,926 pesetas. With regard to imports, an increase is observable in the following articles: Glass and china ware, drugs and chemical preparations, cotton, vegetable fibers, papers, wood, live stock, machinery and carriages. Of imports of a more special nature, railway material, gold and silver, have increased, while tobacco for the Compana Arrendataria has increased to the extent of nearly 12,000,000 pesetas. Exported articles show an increase except wool, live stock, machinery and foodstuffs. The value of exported Spanish wine of a common class has decreased by about 20,000,000 pesetas and of spirits and olive oil by 12,000,000 pesetas. Oranges, on the other hand, exceed the preceding year's export by 11,000,000 pesetas. The customs dues collected show 8,205,824 pesetas less than in 1896, attributable in large measure to the decrease in imported cereals."

Grindstones.—The production in 1897 was 37,200 short tons, against 31,309 short tons in 1896. There were six producers. With the exception of a little that was quarried in Michigan, the entire product originated in Ohio.

SPEECH OF HON. THOMAS A. JENCKES, IN DEFENSE OF THE PATENT SYSTEM.*

MR. SPEAKER: There are some general considerations upon the subject of the patent laws which I wish to present to the House before asking a vote upon the passage of this bill.

Patent laws are based upon the belief that the field of the useful arts may be extended, and that many things which may add to the comfort, the well-being and the prosperity of mankind yet remain to be discovered. These laws give to every one who thus by his inventive genius adds to the sum of human knowledge, in either of the ways indicated, a protection for a few years to the exclusive use of his invention or discovery. They offer a premium upon the exercise of this talent for the benefit of mankind. They recognize a man's right to the fruit of his own mind upon the condition that he shall teach the public how to use his invention without price forever after the termination of the period for which his use is exclusive. Property in ideas, and protection to that property for a limited period, is the vital principle of these laws. If he who can teach us how to make two blades of grass grow where but one grew before is a public benefactor, how much more so is he who constructs for us a machine or explains to us a chemical process by the use of which one man can bring about a greater and more perfect result than a hundred men could do before? This is the domain of invention, and so far as it is genuine, the law follows it with its protection for seventeen years.

But why protect it at all? say many. If an invention had not been perfected by this patentee to-day, it would have been at some subsequent time by some other inventor. Why not wait and let it be produced in course of time, according to the necessities of the art in which it is developed and without any expense to the public? This objection touches precisely the point of the whole matter and affords the best argument for the patent laws. It admits that invention is a question of time and that the results of invention are desirable and valuable. The patent laws offer a premium upon the earliest time. If it be known that any art or manufacture could be improved by invention in any particular, the question is, Is it likely that such improvement will be made sooner by protection of the inventor, or will it be delayed indefinitely without such protection? The solution of this question does not rest in speculation. The history of inventions determines it. The loom is as old as civilization, but the power loom was perfected under the stimulus and protection of the patent laws. So was the machinery for spinning. The philosophy of steam may have been ancient, but the steam engine is a creature of the patent laws.

These are but individual instances. They might be increased till the mind and memory would be burdened by the catalogue. The assurance that thought, skill and inventive talent may gain fame, honor and fortune by an early solution of the problems in science and art that are pressing upon us brings into the enjoyments of this age improvements and discoveries that might not have been known for centuries later. The theologians will not admit that any new developments or discoveries can be made in religion; the politicians have not advanced much in their arts beyond those we read about in ancient history; in the fine arts the greatest genius of the present day can hardly hope to excel "the old masters;" in architecture nothing has been produced within the last five hundred years to surpass that which has been known, admired and reproduced for twenty-five hundred.

The sphere, therefore, in which original genius and inventive talent can best obtain recognition, honor and reward is that of science and the useful arts. Therein, under the protection and fostering care of laws like that which we now reproduce, has been the greatest progress of the world within the last century, and in many branches of those arts the progress has been greater within the memory of living men than in the entire previous historic period. As the desires and necessities of mankind are the same in all generations, there must be some reason why this advancement is found in the nineteenth century instead of in the ninth or the tenth, or in any of those centuries which are mere barren wastes in the history of civilization. Certainly one reason is because there is some incentive in this era for the development of improvements in this sphere. It cannot be found in the necessities and desires of the race alone, for those have been always the same; and those who have ministered to their wants and necessities, with the means known to previous generations, have been the most strenuous opponents of the introduction of these new inventions.

It is not true, as argued by one of the most illustrious of the opponents of the patent laws in our time, that manufacturers will welcome and adopt an invention which seems to be called for by the necessities of their particular manufactures. This has never been the case where the profits of capital and labor have been disturbed by a new invention which created a revolution in a particular art or manufacture. "It may seem a paradox," says a distinguished author discussing "the rights and wrongs of inventors," "but it is no less true that inventors' patrons are among their most inveterate opponents." The inventor of the machine for making paper, Fourdrinier, was driven out of France, and it took him ten years to introduce his machine into England in opposition to the methods of paper making by hand. The inventor of the loom for weaving variegated patterns in fabrics, Jacquard, was in danger of his life from his colaborers in Lyons, and the capitalists and artisans whose money and labor were dependent upon the use of the old looms for their profits fought for years against the introduction of the revolutionary invention. The conflict is still recognized in our tariff laws. In our own country we know of the opposition to the steamboats, the locomotives, the mowing and reaping machines, the sewing machines, the revolutionary inventions in the manufacture of carpets, paper, iron and steel. In no case does the capitalist welcome an invention which requires him to reconstruct or lay aside the machinery used in the manufacture from which he derives a profit; nor is it looked upon with favor by the laborers, nine out of ten of whom it threatens to throw out of employ.

The necessities of any art or manufacture do not prompt invention. The conservative tendencies both of capital and labor array themselves against it. The inventor is more frequently than otherwise disconnected with the trade or manufacture to which his invention applies and from which he seeks his reward. But the necessities of the public, the consumers of the product of the art and manufacture, all the time demand improvement and increased cheapness. The premium to inventors by the limited protection of the patent laws is thus directly in the interest of the public. When it is said that an invention would have been made at some time if not at the time it was made, without the stimulus of the patent laws, who can tell at what time? When would any modern invention that might be named, the sewing machine, for instance, have been produced if the inventors had not expected a profit upon it?

What invention can be named which this generation would willingly have parted with and consented to have postponed till the next century, by reason of the extravagant price we have paid for it under the patent laws, whose stimulus and protection have caused it to be made in our time? Would we, then, part with the cotton gin, the locomotive, the steamboat, the electric telegraph, the sewing machine, the cast iron plow, the reaper, the machines for gathering the hay crop, the planing machine, the improved steam engine, the rotary printing press? I have mentioned only those inventions which are embodied in wood and metal. But for the small consideration which the inventors or those working the inventions have received, would we have parted in our time with vulcanized rubber and its thousand uses; with illuminating gas; with all the arts of dyeing and printing, which have extracted from waste weeds and the refuse of the gas factories the colors which vie with the Tyrian purple; with the wonders of the lithographic and photographic arts; and with all those wonderful substances, with almost magic properties, which are the products of chemistry as applied to the arts? I challenge a reply from the most bigoted opponent of the patent laws.

These inventors have been questioning Nature, and her kind responses have been a benefit to themselves as well as benefactions to mankind. But while the law has encouraged them, capital, from its conservative instincts, has always been opposed to them. Those who have invested their means in the machinery and apparatus which is well known, and in common use, in any particular branch of manufacture, do not like to be confronted with an inventor who can demonstrate that he can produce the articles manufactured in a better and cheaper manner by a method which requires new investments of capital and makes the old apparatus comparatively worthless. The manufacturers of the old musket did not welcome the inventors who brought them the breech-loader and the magazine rifle, requiring new tools for their construction and consigning the old to the scrap heap.

Invested capital would never encourage or adopt new and revolutionary inventions. It would be a benefit to all now engaged in manufactures if no new improvement was made in their machinery for twenty years or until it was worn out. They would be saved the cost of making the changes required by the new invention. There is an historical anecdote which illustrates perfectly the relative position of the capitalist who believes that he has assured possession of the art in which his capital is invested and the inventor whose invention would render those investments of little value. It is a remarkable incident in the history of the lost arts preserved in the curious gossip of Petronius.

"A certain skillful workman used to make crystal vases as strong as vases of gold and silver. He produced an incomparable masterpiece. It was a chalice of astonishing beauty, which he thought worthy of Cæsar only, and which he felt a pride in offering to him. Tiberius highly praised the skill and the rich present of the artist. This man, wishing to increase still more the admiration of the prince and secure his favors to a greater degree, begged of him to give back the vase. He then threw it with all his might on the marble pavement of the apartment; the hardest metal could never have resisted this terrible shock. Cæsar appeared moved and was silent. The artist, with a triumphant smile, picked up the vase, which had only a slight dent and which, by striking it with the hammer, was soon brought to its original state. This being done, no doubt remained in his mind that he had conquered the good graces of the emperor and the esteem of an astonished court. Tiberius asked him if he was the only one who knew how to work crystal in so remarkable a manner. The workman immediately answered that no one possessed the secret. 'Very well,' said Cæsar, 'let his head be struck off without loss of time; for if this strange invention were known, gold and silver would very soon have not the least value.'

"Thus did the Emperor Tiberius encourage artists and the arts."

And in the same way do our manufacturing capitalists encourage inventions and inventors. They unconsciously imitate Tiberius, and although they cannot, like Cæsar, strike off the impertinent inventor's head, they too often have turned him off to starve. But under our patent laws, as they were established in 1836, the inventor, if he be prudent and thrifty, is assured of a certain compensation. Under the existing constitution of the Patent Office, its seal is evidence that its possessor is entitled prima facie to a new and useful invention. The number of persons skilled in the useful arts and the business to which they appertain has largely increased. There are many skilled persons who can estimate with approximate correctness the value of every new invention. Under this American system of patents, in itself as great an invention as any that are protected by it, inventions have become commodities of marketable value. No inventor now needs to sacrifice his invention for subsistence. Some, perhaps, have anticipated the period of their greatest usefulness; but every genuine invention now has its value, a great portion of which can, with ordinary care and prudence, be realized by the inventor.

Without this protection we should return to the era of "secrets," when every valuable discovery was carefully guarded by its possessor or parted with only upon terms which required the purchaser to be equally silent and uncommunicative. The public obtained no useful knowledge of the art and but a limited advantage from the working of the discovery. The evil consequences of that system were twofold. The knowledge of many valuable inventions and discoveries died with their possessors and are now among the lost arts; on the other hand, empirical processes of fictitious value were imposed upon manufacturers under the guise of "secrets" in the arts, and the whole subject of invention and the character of inventors became discredited and debased. The injury to the progress of the useful arts by these pretended secrets has been greater a thousandfold than any that has arisen from the abuse of even the most imperfect system of patent laws.

Now every invention published through the Patent Office adds something to our knowledge, and, if useful, increases the material wealth of the world. And I do not hesitate to say that the sum of these values, the aggregate increase to the wealth of this country, from the inventive genius of the people fostered and protected by the patent laws, has been greater than that derived from all the protective tariffs passed since the government was organized under the Constitution. A protective tariff deals only with the known elements of labor and skill; as with cottons produced in this country with the same machinery, labor, and skill as they are produced in England and France, and with iron as produced in Scotland or Wales. But invention takes a stride forward of the known mechanism and processes and calls for a higher degree of skill. Who can estimate the effects of the invention of the cotton gin upon this country? Not its value in money merely, but its effects socially, morally and politically? Consider the results from the leading inventions I have named, and see how small are the results from the manufacture of coarse cottons and pig iron when compared with the great interests these inventions have created in the country.

The most distinguished of the opponents of the patent laws has argued in favor "of putting an end to the notion that every person who invented anything had a right to a patent," and that "the giving of patents was a matter of grace and favor in well-selected and discriminated cases, in the exercise of a discretion by an authority intrusted with that discretion;" and in his superlative wisdom he expressed the opinion that "at the period of progress in the history of the arts and trade at which they had arrived they could do much better without these props. He called them props because they were meant to be so, but he believed that at present they were nothing but obstructions and hinderances to trade and the arts." This was said of the patent laws of Great Britain, where there is no preliminary examination and investigation into the rightfulness of the inventor's claim, but where any one can take a patent by paying the fees, if he claim to be either an inventor or the person who first introduced an invention into that country.

Our American system of patent law defies such narrow, carping, illiberal and unjust criticism. It acknowledges and declares that the first and original inventor of anything new and useful has a vested right to its protection by a patent for a limited term upon the compliance by the inventor with certain mild and prudent conditions. It provides for a discrimination which shall determine what the invention is, not as a matter of grace and favor, or in the exercise of an uncontrolled discretion, but as a matter of right as between the inventor and the public. It is not based upon the idea that invention has reached its highest flood and must soon be subject to a returning ebb; or if the results of invention be likened to a structure, it does not consider that it is now complete and perfect, finished and furnished, and that the "props," which patent laws were, may now be knocked away; nor does it consider that these laws are obstructions and hinderances to trade and the arts.

Under the beneficent provisions of these laws the results of the inventive genius of our people have developed, and are now being developed, in almost geometrical progression. Never at any time in the history of the world have so many and so valuable inventions been made known through the Patent Office. The inventors of all nations seek this country for the protection of its laws. Every invention thus acquired, as well as any now produced at home, is the planting of a new industry which needs no other protection from legislation, to grow and prosper, than that which is afforded by these laws. The rise of this inventive genius is not like that of the tide which must reach its limit and recede, but like the increase and swelling of a river, which will not diminish while its course, which is that of time itself, shall continue.

There is nothing of which this nation may be more justly proud than its progress in the industrial and useful arts. No greater and more beneficial results to mankind have been attained in the whole history of the race than have been accomplished within the last three-quarters of a century and in this country. If we look back over the whole history of invention, we are surprised to see how meager and barren it is compared with what has been achieved almost within our time. The country acknowledges always this great glory which its citizens have acquired. The nation takes pride in the record of the results of that inventive genius which is preserved in one of the grandest temples ever dedicated to art and science by any nation or in any age; and it knows that great as is its renown in arms, in the spread of liberty and in the success of free government, there is no brighter coronal that adorns the Republic than that which is enwreathed from the contributions of its inventors to science and the useful arts.

* Delivered in the House, April 22, 1870. This speech sets forth so ably and fully the merits of our patent system, that we republish it entire for the benefit of our readers. Although it was delivered in Congress nearly thirty years ago, there is little that need be added to it, and it stands to-day, in the importance of its teachings, on a par with the celebrated speech of Senator Platt, of Connecticut, in 1884.

Floor Oil Without Paraffine.—A solution of yellow beeswax in turpentine is used with good results. An alkali is occasionally combined with the mixture, as in the following:

Yellow wax	8 ounces.
Potassium carbonate	1 "
Oil of turpentine	1 "
Water	32 "

Heat the wax and water to boiling, add the potassium carbonate, boil another minute, remove the vessel from the fire, add the oil and stir until cold.—American Druggist.

SOME BOTANICAL CURIOSITIES.

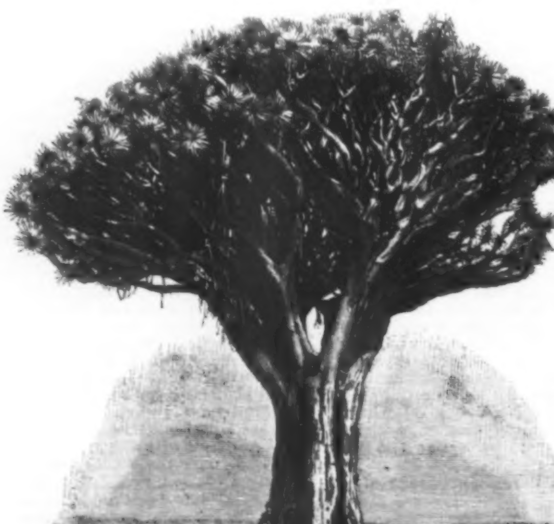
We present two engravings of some interesting botanical curiosities taken from our German contemporary Vom Fels zum Meer. The dragon tree (Dracæna Draco) belongs to the Dracæna, of the liliaceous genus, and is a native of the tropical regions of Africa, Asia and Polynesia. This genus includes about thirty-five species; the leaves are large, lanceolate and entire, often somewhat fleshy and borne in tufts at the ends of the branches. The flowers are small and the fruit is baccate. The various species are cultivated in greenhouses and in ornamental grounds on account of their foliage and general appearance. The most remarkable species is the dragon tree shown in our engraving. This is the Dracæna Draco of the Canary Islands, which yields a resin of great value in the arts,

BALSAM PLANT GROWING OUT OF A HORIZONTAL FLOWER POT.

called "dragon's blood." It is of rapid growth and sometimes attains a gigantic size.

The particular tree shown in our engraving was at Orotara on Teneriffe and was destroyed by a hurricane in 1867. It was seventy-five feet high and of enormous growth, being seventy-nine feet in circumference at the base. It was almost the same size in 1402.

The fruit is round, pointed, scaly and the size of a large cherry. When ripe it is coated with a resinous exudation known as "dragon's blood." The finest quality is obtained by beating or shaking the fruit, sifting out the impurities and melting by exposure to the sun or by placing in boiling water. The resin thus purified is then usually moulded into sticks and is shipped to market wrapped in palm leaves. An inferior quality sold in lumps of considerable size is extracted from the fruit by boiling. Dragon's blood is dark reddish brown; it is brittle and nearly opaque; it contains small shell-like flakes, and when ground produces a fine red powder. It is freely soluble in alcohol, ether and fixed and volatile oils. In Europe it was once valued as a medicine on account of its astringent properties. It is now used for plasters,



THE DRAGON TREE OF TENERIFFE.

dentifrices, lacquers and varnishes. In China, where it is mostly used in a crude state, it is employed to give a rich color to writing paper. It is of great value in photo-engraving, where it forms the resist on the zinc or copper plate. It is held firmly by the ink and the various dustings with dragon's blood are melted in, thus covering the line during the first steps of etching and protecting the line from undercutting during the subsequent operations.

Our other engraving shows a member of the balsam family growing out of the flower pot placed horizontally. The balsams are a flowering annual of Eastern origin, cultivated in many varieties. It is often called "garden balsam" and in the United States the "lady's slipper." The particular variety shown in the engraving is the "balsamine" or garden balsam. The balsams are of great value in medicines, but the word "balsam" does not always refer to the plant balsam (Impatiens balsamina). Thus "Balsam of Saturn" is a solution of lead acetate and turpentine concentrated by evaporation. Canada balsam is obtained from the bark of the balsam fir. The illustration is an interesting sample of a botanical curiosity. The flowers frequently raise their heads in this astonishing manner in order to present their leaves and flowers to the sunlight.

PRESERVATION OF ALGÆ.

A method of preserving algæ for demonstration purposes is published by C. Thom, which has the advantage of preventing shrinkage. The plants are killed and fixed by the use of Flemming's weaker solution (10 c. c. of 1 per cent. osmic acid, 10 c. c. of 1 per cent. acetic acid, 25 c. c. of 1 per cent. chromic acid, and 55 c. c. of distilled water). This may be used from half an hour to twenty-four hours or more without injury to delicate tissues. Next add 10 per cent. of glycerin, allowing each drop to diffuse before adding more, so as to prevent the shrinkage caused by diffusion currents if glycerin is added too rapidly. Continue adding glycerin until enough has been added to cover the specimens, when the fixing solution has evaporated from a watch glass in which they are exposed for the purpose. The red algæ retain their color almost perfectly, but green algæ lose more or less color, although the chromatophores retain their shape perfectly, and the cells become clearer than fresh material.—Botanical Gazette.

EMERY IN ASIA MINOR.

For many years Asia Minor has been the chief source of supply for emery. A paper on this and other minerals in the Villayet of Aidin, Asia Minor, was read at the Atlantic City meeting of mining engineers last month by W. F. A. Thomae, of London, Eng. In the course of the paper Mr. Thomae said:

Many of the emery deposits are now exhausted, at least so far as profitable working is concerned, though there are others that have not yet been touched. The chief supplies come at present from some of those on the Gumush Dagh, and some further south on the slopes of Ak Sivri.

The deposits worked are of two kinds: (1) the mineral solid and in situ, when it is known as "rock emery;" and (2) emery detritus, resulting from the weathering of the former.

Rock Emery.—These deposits are irregular pockets in the limestone. Their maximum width varies from a few feet up to 200 feet, the length also varying up to about 300 feet, and the depth from 10 to 50 feet, as shown in the workings; but the deposits have a greater depth in cases where there has been, so far, enough ore near the surface to make deeper sinking, with its attendant cost, unnecessary. The time will no doubt come when the shallower and more easily accessible deposits will be exhausted, and then deposits now abandoned as unprofitable will again be worked to greater depths. But this time is yet distant.

Sometimes the deposits have an elongated form, a width of 5 to 6 feet, with a length of 200 to 300 feet, and then their outcrop, rising boldly over the softer limestone, has the appearance of a reef or fissure vein.

The walls of the deposits are often exceedingly irregular, and limestone intruding and receding most unexpectedly. The demarkation between it and the deposit is, however, beyond the range of decomposition, always distinct, and there is no gradual merging of the one into the other, though the limestone in juxtaposition is often stained and veined with brown seams. In a few instances, where the decomposed portions of deposits seem to merge into the limestone, this is apparently the result of secondary alteration, subsequent to the formation of the deposits.

The ore forming the deposits is a solid mass of emery, contaminated, however, with an admixture of various silicate minerals. Chief among them are margarite, biotite, chlorite and chloritoid.

A marked feature of the deposits is the usually perfect cleavage and cross cleavage, which break up the exceedingly hard and solid ore into blocks of irregular size, often resembling rough hexagonal prisms or pyramids, flat slabs and other shapes.

It is owing to this kind provision of nature that this hard ore can often be mined without the use of explosives. The degree of perfection of these cleavage planes, however, varies greatly; and, though never entirely absent, they are often so imperfectly developed as to be of no assistance in breaking the rock, in which case resort is often had to the time-honored means of "fire-setting."

Near the surface the ore is weathered; and this alteration and weathering commences along the cleavage lines, so that these are often filled with minerals which may be taken as the result of the incipient decomposition of the ore. These are chiefly margarite and other talcose minerals, the formation of which along the cleavage planes, of course, greatly assists the breaking up of the mass. The extent to which weathering affects a deposit varies very much, owing to the varying composition of the ores, and probably also to the extent to which they have been previously cleaved.

Deposits of Emery Detritus.—These have so far formed the chief supply of the emery market, since, being on the surface and easily worked, though more limited in extent, they have been exploited in preference to the rock emery. They consist of more or less rounded fragments of emery of all sizes, up to large bowlders, embedded in a compact clay, colored in some cases a bright red by the oxidation of the iron in the ore, and filling surface depressions and pockets in the limestone, usually shallow, but sometimes over 20 feet deep.

Sometimes they occur by the side of deposits of rock emery, from the weathering of which they have evidently resulted; at others, no trace of the original deposit is visible, it having been either entirely weathered away or covered up by the detritus.

Quality and Value.—The value of the emery brought to market varies at present, according to the quality, from £2 10s. to £3 15s. per ton f. o. b. at Smyrna or other ports. The way the quality is judged at the mines is more or less empirical. The color and sheen of a fresh fracture, the character and degree of crystallization, the roughness of feel of a fresh fracture, distinguish the marketable emery from that discarded, and serve to classify the different qualities sold. The nearest approach to a systematic test is that originally devised by Dr. J. L. Smith to determine what he called the "effective hardness" of the stone. This operation is now carried out in the following modified form: The emery to be tested is powdered and sieved in a nest of sieves. What passes through a No. 50 mesh but remains on a No. 90 is taken. Of this half a gramme is weighed out. Then a piece of glass, about 2½ by 3 inches in size, is accurately weighed and placed on a large piece of paper. The weighed emery is placed on the glass and gently rubbed with the bottom of an agate mortar for a fixed time (17 minutes), the powder that falls off on the paper being returned to the glass at intervals. At the end of the 17 minutes the glass is brushed clean and weighed, the loss in weight in milligrammes representing the effective hardness of the emery. Thus the best Naxos stone is said to cause a loss of 80 milligrammes, whereas the worst qualities go as low as 25.

It is apparent, however, on the face of it, that this method must be very unreliable, and can only give an approximating clew in very experienced hands.

Working.—The emery is quarried or mined in tunnels opening into big caves, the roofs of which are supported by pillars left standing. It is then picked over by hand and the good emery is taken on camels, carrying about 4 to 5 cwt. each, to the nearest port or railway station, sometimes over 20 miles distant. The transport is sometimes a greater expense than the mining, duty, etc. The royalty to the government is about 13s. per ton, which amounts on the best ore to 17 per cent., on the low-grade ore to 26 per cent. on the f. o. b. value—a heavy tax.

The unsatisfactory character of Turkish administration is almost proverbial, and has scarcely been exaggerated. There is practically no security of tenure for the most legitimate mining enterprises. True, the Sultan's firman for a concession, once obtained, is not to be disputed, but the difficulty is to get this. Without it, no matter how carefully all regulations have been complied with, claimants spring up to contest your rights and stop your work, and are actually encouraged to do so by the government. Does it not put untold backsheesh into the pockets of all officials connected with the law courts and the mining department? And how could these live without such means of getting paid? For years such claims are contested; from one court to another and back again the case is sent, and each time the previous verdict is reversed,

unless one party refuses to bribe any more, when of course the other party is immediatedly successful—until some other claimant springs up. For anyone but a Turk to obtain a firman is practically impossible, unless at the expense of far more money than the concession is worth.

HUNTING FOR SWALLOWS' NESTS IN JAVA.

I HAVE never eaten any of them, and I have never collected any of them, but on the subject of the edible nests of the swallow I have been able to obtain information from the best sources. These nests are, as we know, the work or, more properly speaking, the product of a swallow, scarcely as large as a humming bird, called the "salangane."

It has been asserted that they are made from certain species of fucus, but analysis has demonstrated that they contain 99 per cent. of animal matter, or of a sort of mucilage such as surrounds the spawn of fish, and which at certain periods floats in immense layers upon the seas of China.

The two great hunting grounds are Annam and the Dutch Indies. In Java, the nests are found at Sarabaya, Probolingo, Beseke, and Madara, in the independent state of the Sultan of Djogjakarta, and in the regencies of Preanger, sometimes at the seaside, and sometimes in the interior.

The Dutch, who are a practical people, have been able to turn them to an excellent account, and have had regulations concerning the hunting for them for the last three centuries. At various periods they have declared them free (except the putting of an export duty of from 25 to 62½ florins a picul or an ad valorem duty of 15 per cent. on them) or have reserved the monopoly of them. In the budget of receipts for 1894, swallows' nests figured to the amount of 153,000 florins, say nearly $63,200.

So much for the duty; as for the trade in them, that does not figure by thousands, but by millions. In the innumerable islands that dot the seas of China, from Java to Annam and from Sumatra to New Guinea, hundreds of thousands of pounds are annually gathered; and all that for China.

The culinary monograph of the swallow's nest is summed up as follows: washing in an abundance of water, prolonged decoction in boiling water in order to precipitate the foreign matter, and then cooking in a water bath, either accompanied with some sort of game (by preference a pigeon) or with the seeds of the nenuphar, in order to be eaten plain or sugared. Is it really the exquisite dish that its high price would make it supposed? Is it not rather a rarity (like Lucullus' pie of nightingales' tongues) adapted for flattering the vanity rather than the palate of rich gourmets?

What is certain is that the nests of the swallow are gathered only at the cost of infinite trouble or of worse danger. They are never met with in a place where it would be easy to get at them. It seems that the salangane bids defiance to the gluttony of man, since it forms its nest in inaccessible places that can be reached neither by land nor sea. Well, then it will be reached by air; and so into the sides of the rocks (Annam method) we see bamboo pickets inserted, and forming the unequal and fragile steps of a stairway up which the coolies climb to dizzy heights; or else along the overhanging cliffs (Java method), we see suspended slender vines or flexible ladders, firmly tied to the trunks of trees, that allow the hunter to ascend to the walls of rock to which the nests are attached, or to descend to the subterranean grottoes in which the waves beat and break into foam, and which form the hidden retreat of innumerable birds. These intrepid aerial hunters are all, or nearly all, condemned to perish by accident. They know it, but the thirst for lucre is stronger than their hold on life.

HUNTING FOR SWALLOWS' NESTS IN JAVA.

At Java, not far from Djogjakarta, there is a cliff and a grotto that is very rich in nests. The cliff is perpendicular, and the grotto, which is a little above the level of the sea, is very deep, and is reached from above. A small structure, a simple hut, contains the paraphernalia of the hunters. Behind this hut there is another one just as humble, but it is more than a hut, and almost a temple, let us say a chapel, dedicated to Ratou Kedoul, the protectress of the nest hunters. Its legend, as it was narrated to me, is as follows:

Ratou Kedoul loved a young man, but since he was merely young, handsome, tender, intelligent and good, her father would not allow her to marry him. In despair, she wished to die; so she fled, reached the edge of the sea, near this formidable cliff, and threw herself in. But the gods, who, through pity for her, consented to retire her from this world, decided, through good will to men, to make her immortal. She should inhabit the land and water, and watch over navigators and fishermen in peril. Ratou Kedoul, therefore, built a golden palace for herself at the bottom of the sea. That was ages ago. Here she is still watching over sailors, and removing them from danger, but not allowing herself to be seen by anybody. It is claimed that she dares not show herself to men, because she is naked; and, in this belief, those that remain of her family, especially the reigning prince of Sarakarta, send her annually, on the anniversary of her coronation, a basket of linen and clothing by way of an offering. These are weighted with a large stone and thrown into the water. The princess receives the clothing and puts it on, but persists in not showing herself.

Ratou Kedoul, in the first days of her marine life, liked to come to play along the shore. One day she perceived a young man, and cried to him: "Who art thou?" He answered that his name was Djoko Pravito and that he was very unhappy.

He was the third son of a merchant in middling circumstances. One day this merchant took it into his head to ask his children what they would like to be in life. The first answered a djaksa (registrar), the second a wedono (subprefect), and the third a prince royal. At this, the father at first began to laugh and then got angry and said: "Djoko Pravito will never be a prince royal, since his father is not, and never will be a king, but Djoko will always be a fool." Djoko left the house and began to travel about the world; but the world was not kind to him, and he asked himself, since accident had led him to the sea, if he had not better throw himself in.

Ratou Kedoul consoled him (he was so sad), and looked at him (he was so young); and then, some sort of a whim coming into her mind, she said: "Do not despair, nothing is lost and all may be saved." And so saying, she put her hand into that of Djoko. "Not far from here there is a kingdom, the king of which has promised to adopt as his son him who will interpret the very obscure wish of a man who recently died. This man said that he desired to be interred under the water, in the earth, and in a house. Thou shalt go to the city and have thyself led to the bed of the dead man. Thou shalt wash him, dig a grave for him and erect a tomb to him. In this way the wish will be fulfilled, the enigma will be solved, and thou wilt become a prince. Go, and remember me."

Djoko Pravito went to the city and carried out the orders of Ratou Kedoul, letter by letter, but scarcely had he come victorious from the test, when he married the king's daughter. Poor Kedoul awaited his return for a long time. Djoko Pravito had forgotten her; so she buried herself under the sea, never again to reappear. But the people have preserved her memory and the nest hunters have adopted her as a patroness. In place of the palace that Djoko Pravito ought to have erected to her, they have built an humble hut, proving, centuries ago, what Sully Prudhomme was to embody in this pure form:

C'est l'offrande des moindres choses
Qui révèle le plus d'amour.

—J. Chailley-Bert, in L'Illustration.

A NEW THEORY OF THE MILKY WAY.

By C. EASTON, in Knowledge.

TOWARD the end of a previous article on "Richard A. Proctor's Theory of the Universe" I suggested that if we confine ourselves to those facts known to-day with sufficient certainty, we can only affirm, with respect to the structure of the Milky Way, that we there see marked irregularity of details, and some traces of a regularity at least partial in the principal features of the phenomenon. Before venturing to go a little further I must sum up the facts and considerations on which this opinion is founded. Want of space compels me in an article of this kind to direct in some cases the reader to the sources of information.

Now that photographs of the Milky Way are so widespread, there is no need to insist on the great irregularity that we observe (in projection) in the distribution of the stars, so long as we confine ourselves to a relatively small portion of the galactic zone. It follows, moreover, from the evidence of all the results recently obtained in the study of the galactic phenomenon, that the manner of distribution of stars in space varies, even between limits that are relatively large; in this part of space the stars are widely scattered, in this other part they are gathered together into veritable stellar agglomerations. But, à priori, that does not by any means exclude a fairly marked regularity of the Milky Way, taken as a whole. Suppose that the Milky Way has the form of the well known elliptic nebula in Lyra; unless we admit that its borders are defined by this figure, and a perfect regularity of distribution prevails inside this ellipse, we should see—we being situated near the central portion, relatively void of stars—a "Milky Way" inclosing the heavens in a fashion similar to the one we see in reality.

Besides, this theory of a Milky Way roughly annular or elliptical recommends itself by its simplicity, and appears to be the one most widely spread at the present day.

Nevertheless, if one studies the phenomenon closely, there are, in this theory of a galactic ring, several points that require explanation.

We see, it is true, the Milky Way forming a great circle round the heavens, but, even apart from the irregularity of detail, the galactic light is very unequally distributed on the circumference of this ring. The Aquila part is much more brilliant than the Monoceros part. This is not only seen in the studies made with the naked eye, but also in the star gages; and it is the case for the southern hemisphere as well as for the northern. As for the general naked eye aspect, two minutes' study on a fine evening in September is sufficient to establish the great superiority in brightness of the Milky Way between Sagittarius and Cepheus over that between Cepheus and the Twins. As for the counts and stellar gages, Sir William Herschel found an average of 161·5 stars in his gages about Aquila as compared with 82·5 about Monoceros. Celoria found likewise for all stars down to the eleventh magnitude in an equatorial zone of about six degrees breadth, 58·883 stars in the region containing the Milky Way about 18 h., and 43·822 in the part that the Milky Way crosses about 6 h.* This is a fact that it is quite easy

* Sir John Herschel, Outlines; F. G. W. Struve, Etudes; J. T. Encke, Astron. Nachrichten, xxxvi., 1848, p. 336; Houzeau, Uranographie; Atlas, Mons, 1878; Easton, Voie Lactée, 1893; Astron Nachrichten, 3070; Plassmann, Jahresberichte der V. A. P., Berlin, 1893; Celoria, Pubbl. del Oss. di Brera, xiii.

to establish, but whose consequences have not received the attention that they merit.

Unless we admit that we are situated in the center of the ring, but that in the body of this irregular ring the stars increase systematically, so to speak, toward a point (which is evidently most improbable), we must conclude, as was said above, that the sun in the interior of this hypothetical ring occupies an eccentric position, fairly near the side where is Monoceros, moderately distant from Aquila.

But why, then, does the breadth of the galactic zone in Monoceros differ so little from that in Aquila? Evidently the Milky Way in general ought to appear larger to us the nearer we approach the hypothetical ring, for we could not presuppose (and before such an utterly improbable thing has been proved independently) that the irregularities in the breadth of the zone (any more than the irregularities of brightness) increase toward a given point in the circumference. But at first sight the Milky Way appears, on the contrary, larger in the region of the Eagle, because of the two brilliant branches, and that is why Kant has already placed the sun near to that part of the Milky Way where this constellation is found. After studying it, however, more attentively with the naked eye, and including all the branches, it appears rather broader on the majority of charts in Monoceros than in Aquila, but the difference is far less than theory would indicate. Is this circumstance due to the mode of formation of the visual Milky Way itself? (See my preceding paper.) No; for in the paper of Prof. Celoria we find an easy way of measuring the breadth of the zone where the stellar density is greater than the "average" ("physical Galaxy"*); and it follows from one of his tables—Tavola V—that for the stars as far as the eleventh magnitude (and also for the whole of the fainter stars that W. Herschel saw in his great telescope), the Milky Way is considerably larger in Aquila than in Monoceros, and even (particularly for the relatively brilliant stars 0—11) that the principal branch in the Eagle alone has almost the same breadth as the entire Milky Way in Monoceros, where the galactic light is, moreover, so feeble.

This evidently contradicts the hypothesis of a simple and continuous ring whose parts are all situated at considerable distances from the sun. (Situated in the interior of such a ring, we ought to be able to observe a correlation between the narrow, brilliant and well defined portions on one hand and on the other between the feeble, diffused and broad portions.) The hypothesis that there is a real duplication of the Milky Way into two branches at the same distance from us, over almost exactly the half of its course, is obviously improbable, but it is also incompatible with the reality, for the classic representation of the "simple" Milky Way† in Cygnus, Monoceros and Crux, as opposed to the double portion in Crux, Aquila and Cygnus, does not exist.‡ If we hold to an annular Milky Way, we are compelled to accept at least two rings, which both surround us, but at very different distances. The nearest ring easily explains the very remarkable circumstance that the fairly brilliant stars—those found in the "Bonn Durchmusterung" of about 0—9·5 magnitudes—are, contrary to the others, more numerous in Monoceros than in Aquila, a phenomenon that is repeated under another form in the belt of bright stars of Sir John Herschel and of Gould.§ Celoria, moreover, does not hesitate to admit "due anelli distinti, ne mai interrotti nel loro corso." The stars in the nearest ring are projected on the sky following the circle, Cassiopeia, Hyades, Orion, Crux, Scorpius, Ophiuchus, Cepheus, those in the more distant ring following Cassiopeia, Auriga, Monoceros, Crux, Sagittarius, Scutum, Sagitta. The Italian astronomer does not venture an opinion as to whether these two rings really interlace or are only in projection.

At the time when Celoria's researches were published (in 1878) this theory of two distinct and uninterrupted rings, that appeared to explain fairly well the general features of the galactic phenomenon, did not so much clash as it does to-day with the objection that, presented in this form, it is unacceptable because of the structure of the Milky Way revealed by drawings, and, above all, by photographs. For this reason a single ring (the principal ring, for instance, in Sagittarius and Monoceros) cannot be imagined but by straining probability; as for two complete rings, they are quite inadmissible. The phenomenon is evidently much more complicated even in its principal features.

But is this a reason for throwing overboard the whole of this theory of Celoria's, which rests, moreover, on serious observations and deductions? By no means. It is not admissible in its entirety, but may well be true in part.

Suppose, for example, that these "rings" of Celoria are not "unbroken," nor even complete rings, but annular detached segments roughly disposed in two planes—or, rather, in a "broken plane" (Struve)—the grave objection that we have just raised ceases to exist, and the system is in accord with the results that Celoria and other astronomers have obtained.

But, first, here are some considerations of a different nature.

If we imagine the Milky Way to be an assemblage of stars and clusters of stars distributed quite by chance, we ought to find in all regions of the galactic zone the same characteristics very nearly; these characteristics depending on the chance of the projection, which should manifest itself sensibly in the same manner in all directions. The details of the distribution will differ greatly in one direction from another, but the general character—the type—will depend only on the general conditions of the whole; the limits between which vary the stellar density, the volume and brightness of the stars in different parts of the system, the frequency of nebulosities and of opaque bodies, etc.—this type will be constant.

In reality it is not so in the Milky Way. Those who have studied it best, both in its aspect to the naked eye and on photographs, will recognize, I believe, that the character of the Milky Way is not the same in Sagittarius and Scorpius, where brilliant and irregular masses, which rather appear to be individually connected with parts of the secondary branch (or with its brilliant stars), alternate with dark or poor regions; in the region of Andromeda, Lacerta and about ε Cygni, where an even stream runs parallel to the galactic axis; or in Cassiopeia, Perseus, and Monoceros, where the tendency to duplication has been noticed in some cases independently by Boeddicker, Easton and Pannekoek; or in the region round Aquila to the west of Altair, where there is arranged a series of fairly bright patches.

A remarkable peculiarity of the general distribution of the galactic light between α and ζ Aquilæ and β Cassiopeiæ is that in the principal (following) branch the brightness decreases gradually from the interior border to the exterior, while the secondary (preceding) branch is much more uniform. There is only one exception, but that is a curious one: between γ Sagittæ and ν Cygni it is the principal branch that appears dull, while a great brilliant patch stretches between β and γ Cygni, on the interior border of the secondary (preceding) branch; it encroaches a little on the dark interspace. A small, very brilliant patch, a little distant, between α and 68 A Cygni, is situated exactly on the galactic axis.

I will only recall here the well-known argument of Sir John Herschel on the dark spaces with well-defined contours in the midst of a luminous zone (Coal-Sack); a similar opening, in connection with a dark, large rift, visible to the naked eye, passing between 68 A and ρ Cygni, is found in a dim part of the zone between α Cygni and α Cephei—first drawn, I believe, by Heis. These two are the chief. The probability is, in fact, very great that we have here veritable holes in a "galactic band or stream," fairly shallow, and fairly remote from us.

We may add that the dark regions which often stretch over large spaces, and which sometimes form veritable intervals between two luminous streams and occasionally bear the character of fissures in a bed of luminous matter (Mr. Ranyard and Mr. Maunder especially have drawn attention to these curious dark lines in this same magazine*), indicate that in several regions the Milky Way is principally formed by a band or layer, relatively shallow (which does not prevent another band or clusters of stars being possibly projected upon this layer), but fairly extensive in longitude and latitude. Sometimes, as between 74, 68 A, and ρ Cygni, a large fissure crosses the greatest part of the Milky Way in all its breadth. All this does not easily fall in with the theory which only sees in the Milky Way agglomerations, wholly chaotic, of stars and clusters.

The very extensive nebulosities, discovered lately by the aid of photography, which sometimes envelop an entire constellation (Orion, Scorpius), and which are certainly related to the stars, furnish also a valuable argument for the theory that certain extensive parts of the Milky Way are in reality associated, and form each a more or less complete whole.

Thus, I believe, we must come back to this consideration. In detail, the real distribution of the stars in the Milky Way is very irregular. In the grouping of the stellar agglomerations there is manifested, however, in a certain degree, a systematic distribution. This organization of the stellar matter does not, however, go so far as to produce a geometrical figure of any regularity whatever—ring, ellipse, or one or more rings, concentric or interlaced.

The undoubted connection between certain stars, nebulosities, and parts of the Milky Way overthrows the theory that the Milky Way is infinitely more distant from us than the bright stars. Certain regions of the Milky Way may be relatively near us. It follows from the researches of Celoria that in all probability the Milky Way in Orion is much nearer us than the opposite parts of it. But the same conclusion is arrived at for other portions of the Galaxy. I believe that "Holden's ellipses"†—stars ranged in chaplets, etc.—are not, at least in certain cases, the result of optical illusion (see the magnificent photographs published in Knowledge, 1891, October and December—the region between α, ξ, and f Cygni), and that the dark fissures sometimes bordered by long ranges of stars, and other phenomena of the same nature, are undoubtedly real. Whatever may be the reason of these strange peculiarities of distribution, it is indeed too difficult to imagine that the regions where they are produced are at incommensurable distances.

Sir John Herschel has already pointed out that the "long lateral offsets which at so many places quit the main stream of the Galaxy, and run out to great distances, are either planes seen edgeways, or the convexities of curved surfaces viewed tangentially, rather than cylindrical or columnar excrescences, bristling up obliquely from the general level." ("Outlines," § 792.)

There is nothing, indeed, inadmissible in such trains of stars—veritable branches of the Milky Way—lying across the interior of our stellar system, and in some cases coming near our sun. Combining this supposition (which gives a plausible explanation of more than one question) with the theory of "segments of a ring," to which Celoria's theory might be reduced, we find a system of spirals, the most simple figure that we can imagine the Milky Way to assume according to this train of thought.

As an analogy from what we see in the heavens, I will take, not the nebula of Lyra, but rather the nebula Mess. 101 Ursæ Maj. (Roberts, "A Selection of Photographs," 1894, p. 32; also Knowledge, February, 1897, p. 54, Fig. 2), or else the celebrated spiral nebula in Canes Venatici, Mess. 51 Can. Venat. (Roberts, ibid., p. 30; and Knowledge, February, 1897, p. 54, Fig. 4).

This analogy also leads us to seek for a central nucleus toward which the spirals may be directed. Now there is one region in the Milky Way which it indeed appears may occupy such a position.

In discussing Celoria's theory we have seen that, to explain the more general traits of the galactic problem, we might place the sun eccentrically in one great ring (nearer to the Monoceros border), and inside a smaller ring. As the points of intersection of these two hypothetical rings, inclined to each other at about nineteen degrees, are distant from each other in the heavens about one hundred and eighty degrees (Crux—Cassiopeia), it was better to imagine the inner ring as fairly small. On the other hand, the sun ought to be near that part of this small ring which is in the direction of Monoceros, since this region is fairly well resolved into separate stars (see my preceding article). If Celoria had made his counts, not along the equator, but at about thirty-five degrees, he would have found that this secondary "ring," very dim in general, has one brilliant portion in Cygnus; and this portion, opposite to that region to which our sun is nearest, is situated (in the smaller ring) at the middle of the system.

Besides, the part of the Milky Way in Cygnus is remarkable from more than one point of view. The luminous spot β—γ Cygni is the only luminous patch situated in the "secondary branch," but near the dark space. It is an exception to the manner of distribution of brightness over the breadth of the Milky Way, between the Eagle and Cassiopeia. It is evidently connected with several other very brilliant regions (the spots α—A, ρ—π Cygni, etc., perhaps to the series of spots west of Altair). There are in the Milky Way other more luminous spots, but they are much smaller. Sir William Herschel here found his maximum gage (588 stars in a telescopic field of 15·4′). Not far from here, Kapteyn* placed the center of the agglomeration of bright stars in the neighborhood of the sun. Without wishing to dogmatize, it is here that I would place the central condensation of a galactic spiral; the sun is thus found between this central nucleus and the spirals directed toward Monoceros, in a region relatively sparse. As to giving a rather more definite form to such a spiral, it is a research that I have sometimes attempted, but it would be premature to give the result here; moreover, many kinds of spirals are in accord with the theory.

For want of space many considerations could not be presented or only glanced at. In concluding I wish to insist that this theory does not pretend to give an explanation of all the facts that are grouped about a phenomenon so complicated as the Milky Way, but that it is to be taken above all as a "working hypothesis."

* Le regioni in cui le densità stellari sono più grandi della densità media si possono chiamare regioni lattee." Celoria, ibid., p. 43.

† "Thence" (Cygnus to Perseus, etc.) "the stream is single." Proctor, Monthly Notices, xxx., p. 50.

‡ Boeddicker, The Milky Way; Easton, La Voie Lactée, etc.

§ Celoria, ibid.; Sir John Herschel, Outlines; B. A. Gould, Uranometria Argentina, I.

* See Knowledge, 1891, October, December; 1892, May; 1893, April; 1894, October; 1895, January, February, August, November; 1896, February.

† Holden, Publications Washburn Observatory, II.

* Kapteyn, Verslagen Kon. Akademie v. Wetensch. te Amsterdam, 1892, 1893.

ANNEALING TAP STEEL.

The following remarks by Mr. F. A. Pratt, of the famous American firm of Pratt & Whitney, will commend themselves to all who have had experience in working tap steel:

"We have most of our tap steel annealed at the place where it is made. We have had it done in this way for some years, with the exception of our long staybolt taps, which we have found to require more care in annealing than the steelmakers give them.

"More steel is injured, and sometimes spoiled, by over-annealing than in any other way. Steel heated too hot in annealing will shrink badly when being hardened; besides, it takes the life out of it. It should never be heated above a low cherry red, and it should be a lower heat than it is when being hardened. It should be heated slowly and given a uniform heat all over and through the piece.

"This is difficult to do in long bars and in an ordinary furnace. The best way to heat a piece of steel, either for annealing or hardening, is in red-hot, pure lead. By this method it is done uniformly, and one can see the color all the time. We do some heating for annealing in this way, and simply cover up the piece in sawdust, and let it cool there, and we get good results. All steelmakers know the injurious effects of overheating steel and of over-annealing, but their customers are continually calling for softer steel and more thorough annealing. Until users are educated up to the idea of less annealing and to working harder steel, both will suffer, for the user will continually complain of poor steel.

"Several years since we caught on to the fact that steel was injured by over-annealing, and that good screw threads could not be cut in steel that was too soft; our men would rather take the steel bar direct from the rolls without any annealing than take the risk of annealing. At present we get it from the makers in passable condition, but not as it should be, and unless the steelmakers find some way to heat the bars of a uniform heat, and at a low cherry red, we must either use it raw from the bar or anneal it ourselves. We find, also, that this soft annealing makes a much greater shrinkage and spoils the lead of the thread, and that from the bar without any annealing there is very little trouble in this respect.

"When O. H. and Bessemer machine steel was first introduced, it was poorly made and hard to work. Users constantly urged the makers to make it softer, until when a maker could say his steel was as soft as iron, and not more than 0 10 to 0·15 of 1 per cent. carbon, he had the market. This company found out early that this soft machine steel was almost worthless. A shaft would bend easily in working, and if a lead screw was to be cut it was not possible to get a smooth thread and a good finish.

"Now we either make shafts and spindles of cast steel of a high carbon or of machine steel of about 50 per cent. carbon, without annealing. Our men kicked at first, but now they complain if it is soft, because they cannot cut a good thread and cannot keep it as true."

The Pennsylvania Railway Company is now having a machine made at Alliance, O., for cutting and splitting old ties into locomotive kindling. The new machine will shear the ties to any desired length and at the same time split the block into proper sizes for use; its capacity will be about ten cords of wood per hour.

Gems and Precious Stones.—The production of 1897 was valued at \$62,000, against \$200,000 in the previous year. In reality, there was no such falling off, since we are now convinced that the statistics for 1896 were exaggerated. It is obvious that the collection of statistics concerning these stones is not capable of the same precision as in the case of the commercial metals. Of the production in 1897 we make the following division: Sapphire, \$4,000; ruby, \$1,000; tourmaline, \$2,500; quartz crystal, \$5,000; smoky quartz, \$1,500; gold quartz, \$4,000; agate, \$1,000; moss agate, \$1,500; silicified wood, \$2,500; garnet (pyrope), \$2,000; Amazon stone, \$1,000; turquoise, \$25,000; fossil coral, \$500; arrow points, \$500.—Engineering and Mining Journal.

ENGINEERING NOTES.

Dynamite was used to separate parts of the cable machinery in the power house of the Capital Traction Company, Washington, D. C., which was destroyed by fire some months ago, says Engineering News. Attempts to separate the hubs of some of the large wheels from their shafts proved fruitless, and as a last resort they were blown off. Notwithstanding the fact that precautions were taken to prevent accident, portions of the wheel were blown several blocks. Fortunately, no one was injured.

The Ceylon Mail records a curious salvage case. The steamer "Ganges" found helpless in the Red Sea the steamer "Fernfield," bound for New York. The "Fernfield's" main steam pipe had burst, and she wanted to be towed to Perim, the nearest port. The "Ganges" undertook the job, and had done 200 miles when her hawser broke. Thereupon the captain of "Ganges" ran his vessel alongside the "Fernfield," despite a heavy sea, lashed the ships together, and in this queer fashion safely reached Perim.

At the works of Schneider & Company, at Creusot, France, various protecting coverings tried, such as silicate cotton, plastic compositions, etc., did not give good results, besides being costly, says The Engineering and Mining Journal. Finally, experiments were made with a mortar formed of granulated slag mixed with soot taken from the boilers or Cowper stoves. This compound is laid on easily with a trowel in thicknesses varying from 1¼ inches to 2¼ inches, according to the size of the pipes. It is then wound round with felt, and a sheet steel covering is fitted over the felt for such pipes as are in the open, this casing being replaced by a cloth wrapping where the pipes are sheltered by buildings or shops. This inexpensive method is found to answer admirably, the temperature of the outside of the pipes thus protected being little higher than that of the surrounding air, so that condensation is reduced to a minimum.

Changing the Grade of a Sewer.—Without waiting for the completion of her great drainage canal, Chicago proposes to stop the discharge of her sewers into Lake Michigan, which supplies her with drinking water. Two new sewers are to be constructed, emptying into the Illinois and Michigan Canal, and slight changes will be made in some of the existing sewers to adapt them to this new plan. A rather curious feature of the work in hand is an alteration in the grade of a section, 104 feet long, of an old sewer, so that its contents will flow westward instead of eastward. The inclination is very slight, and the required modification will, therefore, be trifling. A flooring of concrete will be laid on the bottom of the great 6-foot conduit. It will be nearly 18 inches thick at what is now the lowest end and less than 6 inches thick at the other. This difference will be sufficient to give a slope in the opposite direction. The flooring will not be flat, but curved, so as to form a furrow of less width than the original sewer.

Old cables of aloe fiber for footways have been tried by the French engineers at Ceuta, Morocco, for the wearing surface of foot bridges exposed to heavy traffic. Elm plank on oak stringers wore out rapidly, and finally, in 1894, old flat mine cables were substituted, made from the fiber of the aloe plant, and costing from $5 to $6.20 for 220 pounds. The thickness of these cables ranged from 1·37 to 1·96 inches, and their mean width was 8·65 inches, says Engineering News. These flat cables were thoroughly tarred and nailed down to oak plank across the axis of the bridge, and the ends were secured by light iron bands. These footways are found to be very elastic and lasting; they are not slippery, and the weight is only about 92 pounds to the square yard. They are somewhat expensive, as the finished cost, including the cables, tar, nails, bands and labor, was about $3.76 per square yard. Up to the present time they show no trace of wear, though the daily passenger traffic passing over them varies from 600 to 2,000 persons.

The introduction of a hospital car on the Belgian railroads is noted by Consul Morris, of Ghent. The simple design of this is, as explained, that in the event of a serious railroad accident the car may be run to the spot where the wounded may be picked up and carried to the nearest city for treatment, instead of being left to pass hours in some wayside station while awaiting surgical attendance. The interior of this car is divided into a main compartment, a corridor on one side and two small rooms at the end. The largest compartment, the hospital proper, contains twenty-four isolated beds on steel tubes hung upon powerful springs; each bed is provided with a small movable table, a cord serving to hold all the various small objects which may be needed, and each patient lies in front of two little windows, which may be closed or opened at will. The corridor on the outside of the hospital chamber leads to the linen closet and the doctor's apartment; in the latter is a large cupboard, the upper portion being used for drugs, while the lower is divided into two sections, one serving as a case for surgical instruments and the other as a receptacle for the doctor's folding bed.

In preserving marine boilers in the French navy which are not in use, the following method is adopted, says Industries and Iron. The boilers are filled with fresh water, and in the case of large boilers with large tubes, a certain amount of milk of lime or a solution of soda is added to the water. In the case of boilers with small tubes, milk of lime or soda is added, the solution, however, not being so strong as for the larger boilers, in order to avoid any danger of contracting the effective area by deposit from the solution. The strength of the solution is just sufficient to neutralize any acidity of the water. Care has to be taken to preserve the outside of the steel or iron tubes in those boilers which are not to be used for long periods. For this purpose they are painted with red lead or coal tar as far as it is possible to reach, while for those portions which are inaccessible a protective coating is obtained by burning under the tubes a certain amount of coal tar, the smoke forming a coating of soot, which prevents the air from reaching the surface of the tubes. Besides this treatment, the boiler casing is closed and kept air tight, after some quicklime has been placed inside. Periodical inspections of the boilers are made to insure the complete filling of the tubes.

MISCELLANEOUS NOTES.

Berlin has female commercial travelers who go their rounds on tricycles, to which are attached their boxes of samples.

Gypsum.—The production of gypsum in 1897 was 235,000 short tons, against 231,649 short tons in 1896. There was a considerable increase in the production of Michigan, where more of this rock is quarried than in any other State, its output rising from 56,000 to 65,000 tons; there was also an increase in the production of Iowa, but the output of Kansas, New York and certain other States fell off.

Paris cab fares are to be changed to a system regulated only by time, the course at 1½ francs being abolished. The first two minutes of a ride will cost 60 centimes, the second and third two 10 centimes each; then follow two three-minute spells at 10 centimes each, so that a twelve-minute ride costs a franc; twenty-three minutes and over will cost 1 franc 50 centimes. Clocks indicating the time and price will be placed in every cab.

Germany, exclusively of special publications, issued last year 3,477 political and advertising papers, coming from 1,752 centers. According to comparison of population, there is one paper issued for every 12,092 inhabitants. In Austria there is only one paper published for 72,299 inhabitants. The export book trade of Germany in 1896 was valued at 62,000,000 marks and the import was worth 20,000,000 marks. In the analysis of these imports, the American percentage is 1·6, and from England the total value was estimated at 650,000 marks. The Tauchnitz publications in Germany of English and American books accounts for this.

While the population of Europe, which was estimated at 175,000,000 in the beginning of the century, rose to 216,000,000 in 1830, 300,000,000 in 1870, and is now nearly 370,000,000, there has been a still more remarkable increase in the number of towns with over 100,000 inhabitants. There were only 21 of these in 1801 (with 4,500,000 inhabitants), 42 in 1850, 70 in 1870 (with 20,000,000 inhabitants), and 121 in 1896 (with about 37,000,000 inhabitants). In 1801 France had three towns with over 100,000 inhabitants, while England and Germany had two each; but in 1870 the figures were: England 18, Germany 10, and France 9; while in 1896 they stood: England 30, Germany 28, and France 10.

A Chinese typewriter has been invented by the Rev. Mr. Sheffield, a Presbyterian missionary at Tung Chow. "It is said," says The Industrial World, "to be a very remarkable machine, and is exciting a great deal of comment over there. As near as can be understood from the description published in the Chinese papers, the characters, about 4,000 in number, are on the edges of wheels about one foot in diameter. It requires twenty or thirty wheels to carry all the letters, and the operator must strike two keys to make an impression. The first key turns the wheel and the second stops it at the letter wanted, which is brought down upon the paper by an ingenious device."

"**From** out of Prentice's red sandstone quarries at Houghton Point, Wis.," says Industries and Iron, "was wrought some time since a monolith measuring 115 feet high by 10 feet square at the base and 4 feet square at the top. It was originally intended to send it to the Chicago Exposition as a Wisconsin exhibit. Engineering and financial reasons, however, intervened to prevent this, and the monolith has lain at the quarries ever since. A movement is now on foot to ship it by water to Milwaukee, and to set it up on the lake to mark the coming semicentennial of statehood. It is claimed that this stone is higher than any recorded single quarried stone in the world. The granite obelisk at Karnak, however, comes very near to it, being 108 feet high."

An exchange, says Ice and Refrigeration, gives some interesting data concerning the number of refrigerator cars in service on the railroads in the United States, which, including ventilated and insulated cars, is said to number about 120,000, but there are only 28,000 actual refrigerator or iced storage cars in use. The average time such cars are in transit, making the trip from Chicago to New York, is fifty-eight hours; from Kansas City to Chicago, twenty-four hours; from Kansas City to New York, eighty-two hours. As to temperatures, each shipper seems to have his own idea as to what is required. Fruits can be shipped successfully at a temperature of 50°; dressed beef at as low as 34°, and not exceeding 45°; dairy products can be shipped at a temperature of 50° successfully. The price of ice to the refrigerator companies varies from $2.50 to $13.50 per ton. An average can be given at $7.50 per ton. This great variation in the price of ice is caused by the difference in seasons and localities. Salt is used for shipments of dressed beef and highly perishable products, but, with the exception of experimental shipments of fruit, where it is important to have the temperature as low as possible, the use of salt is not considered advisable.

"**It is** well known," says Revue Scientifique (Lit. Digest), "that floors have been accused of grave sins. Recently, at the Academy of Medicine, Messrs. Vallin and Laveran have been conducting the prosecution. It is a fact that the ordinary floor retains in its cracks the most injurious dust and the most dangerous germs. These penetrate thence between floor and ceiling, where they can preserve their virulence for a long time. For this reason the cracks of old floors are often stopped up with paraffin or some similar substance. Sometimes, for greater economy, they are calked. In new buildings they are often replaced with cement. But then people complain, for cement is very disagreeable to the feet. M. Capitan, in La Medecine Moderne, tells us of a new kind of floor that is really in the line of progress, if it proves to possess durability. We speak of wood pulp floors, which have no cracks. They are also bad conductors of heat and sound, and in spite of their durability, are soft to the feet like, for instance, linoleum. The wood pulp is mixed with a small amount of cement to increase the resistance of the floor, the price of which is much lower than that of the ordinary flooring. The dried pulp is reduced to powder to facilitate transportation, and this, after being made into a gelatinous mass, is pressed between rollers. When the pulp is dry it is painted to imitate oak or other wood, according to taste."

SELECTED FORMULÆ.

Varnish for Oxidized Silver.—

Alcohol	16 parts by weight.
Red arsenic	3 " " "
Essence lavender	1 " " "

Improved Process of Gilding Without a Battery.—We find the following in the Zeitschrift für angewandte Mikroskopie: In 1,000 parts of distilled water dissolve in the following order:

Crystalline sodium pyrophosphate	80 parts.
12 per cent. solution of hydrocyanic acid	8 "
Crystalline gold chloride	2 "

Heat to a boiling temperature, and dip the article, previously thoroughly cleaned, therein.

Photographic Developer of Great Permanency.—

A.	Water	1,000 parts.
	Hydroquinone	10 "
	Eikonogen	10 "
	Metol	2 "
	Anhydrous sulphite of soda	40 "
B.	Water	1,000 "
	Crystallized carbonate of soda	100 "

Take two parts of A to one of B.—La Vie Scientifique.

To Preserve Strawberries Successfully.—The following rules are taken from a bulletin of one of the German horticultural societies: Carefully remove the stems and calyxes, place the strawberries on a sieve, and move the latter about in a tub of water for a few moments, to remove any dirt clinging to them. Let drain off, and partially dry spontaneously, then remove from the sieve and put into a porcelain lined kettle provided with a tight cover. To every pound of berries take a half pound of sugar and two ounces of water and put the same in a kettle over the fire. Let remain until the sugar has dissolved or become liquid, and then pour the same, while still hot, over the berries, cover the kettle tightly and let it stand overnight. The next morning put the kettle over the fire, removing the cover when the berries begin to boil, and let boil gently for six to eight minutes (according to the mass), removing all scum as it arises. Remove from the fire, and with a perforated spoon or dipper take the fruit from the sirup, and fill into any suitable vessel. Replace the sirup on the fire and boil for about the same length of time as before, then pour, all hot, over the berries. The next day empty out the contents of the vessel on a sieve, and let the berries drain off; remove the sirup that drains off, add water, put on the fire, and boil until you obtain a sirup which flows but slowly from the stirring spoon. At this point add the berries, and let boil gently for a few moments. Have your preserve jars as hot as possible, by putting them into a pot of cold water and bringing the latter to a boil, and into them fill the berries, hot from the kettle. Let cool down, cover with buttered paper, and immediately close the jars hermetically. If corks are used, they should be protected below with parchment paper, and afterward covered with wet bladder stretched over the stop, securely tied and waxed. The process seems very troublesome and tedious, says the author, but all of the care expended is repaid by the richness and pureness of the flavor of the preserve, which maintains the odor and taste of the fresh berry in perfection.—National Druggist.

To Preserve Beef, etc., in Hot Weather.—Put the meat into a hot oven and let it remain until the surface is browned all over, thus coagulating the albumen of the surface and inclosing the body of the meat in an impermeable envelope of cooked flesh. Pour some melted lard or suet into a jar of sufficient size, and roll the latter around until the sides are evenly coated to the depth of half an inch with the material. Now put in your meat, taking care that it does not touch the sides of the jar (thus scraping away the envelope of grease), and fill up with more suet or lard, being careful to completely cover and envelop the meat. Thus prepared, the meat will remain absolutely fresh for a long time, even in the hottest weather. When required for use the outer portion may be left on or may be removed, as the occasion may be. The same fat may be used over and over again by melting and retaining in the melted state a few moments each time, by which means not only all solid portions of the meat which have been retained fall to the bottom, but all septic microbes are destroyed.—National Druggist.

Dried Milk.—Dried milk is one of the most recent results of food industry. It is a yellowish powder, presenting the appearance of coarse rye flour. According to the manufacturers, it gives a product resembling fresh milk when mixed with water in proper proportions. Chemical analysis shows that the water is reduced from about 88 to about 3 per cent. in this powder. Its composition is as follows:

Total solid matter	95 per cent.
Albumen	25 "
Fat	24 to 25 "
Ash	5·7 "
Milk sugar	40 "

It represents ten times its weight of fresh milk and may be used advantageously in coffee, cocoa, etc.—Südd. Ap. Ztg.

Shading Inks.—

1. Paris violet	2 parts.
Water	6 "
Mucilage acacia	2 "
2. Rosaniline acetate	2 "
Alcohol	1 "
Water	10 "
Mucilage acacia	2 "
3. Bordeaux red	3 "
Alcohol	2 "
Water	20 "
Mucilage acacia	2 "
4. Methyl violet	1 "
Distilled water	7 "
Mucilage acacia	2 "
5. Water-soluble nigrosine	1 "
Water	9 "
Mucilage acacia	1 "

—Merck's Report.

THE RESTORATION OF MARIENBURG.

On the banks of the river Nogat, in the fertile delta of the Vistula, is situated the former home of those knights of the Teutonic Order who dauntlessly introduced their German culture and German civilization into the rude North.

When in 1309 the residence of the grand master of the order was removed from Venice to Marienburg, an important epoch began in the architectural history of the old castle; hitherto Marienburg had been a commandery founded in 1280 and a strong wayside castle in the territory of the order between Thorn and Elbing. In order to provide a suitable residence for the new governor of the province, the citadel in front of the castle was torn down, and in its place a façade was erected supported by a beautiful sandstone colonnade, which is preserved even to this day in the palace of the grand master. The new citadel was then connected with the central castle on the northeast, huge bulwarks were constructed about the whole structure, and Marienburg was transformed into the largest and strongest castle of the middle ages. But only for one brief century after the removal of the grand master's residence did the order enjoy that glory for which it was renowned in all civilized lands. From the battlements of the proud castle the cross now disappeared (1466), and in its stead there flaunted the conquering banner of a Polish ruler.

The Polish Waywodes and Starosts who now dwelt in the spacious halls were not economists; they cared little for the preservation of the castle. Gradually the structure, already deformed by various additional buildings, went to ruin. Even the union of the province of Western Prussia with the kingdom of Prussia could not prevent the work of destruction, and the very halls of the grand master's palace were rebuilt for profane purposes. But when the wars of independence diffused a new spirit throughout the land and the dawn of a brighter and better future appeared, men began to think of the old stronghold on the banks of the Nogat. In "Der Freimütige," a widely read journal of that time, appeared the inspiring words of the poet Max von Schenkendorf, which gave the first impulse to the work of reconstruction.

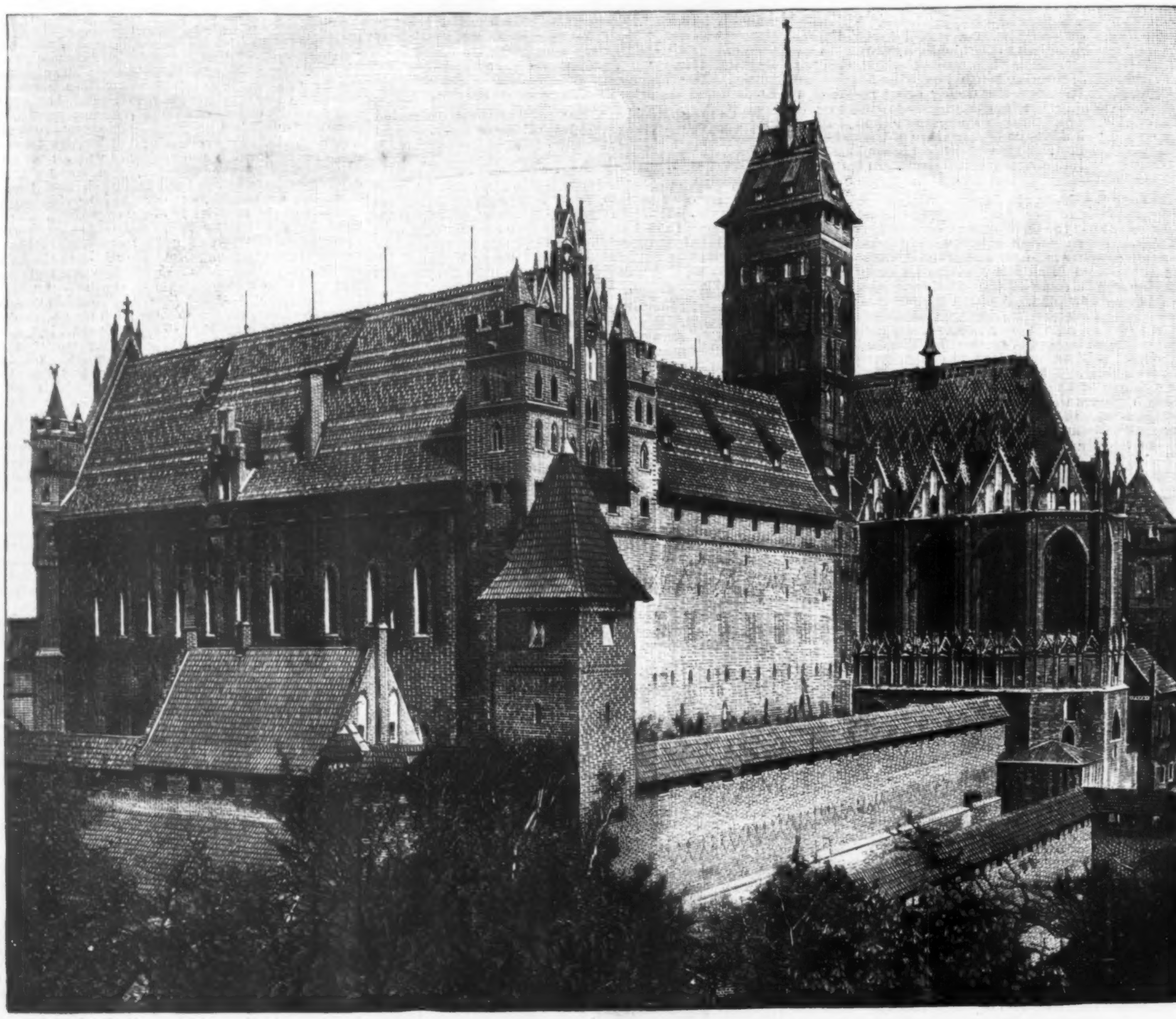
The first period of restoration thus began in 1815 under the direction of the provincial governor Von Schön. Many difficulties at first presented themselves, and it was above all necessary to fix the boundaries of the province definitely, since they had become unsettled during the course of centuries. There were, moreover, other legal matters which had to be disposed of before the work could begin. Although voluntary contributions were not pouring in very rapidly, the task of restoring the ruined castle was, nevertheless, courageously begun. First the enormous mass of rubbish collected in the cellars and vaults was carefully removed; then the reconstruction of those halls and chambers of the grand master's palace which were not already destroyed, was skillfully carried out, so that we may still see the decorations and paintings which graced the walls of the old stronghold in all their pristine splendor. An unsuccessful attempt was also made to restore the central castle, but the interior had crumbled to such an extent that it was almost impossible to follow out the original lines of the structure.* This first period of restoration extended to the year 1848 and gave rise to several errors, chief among which may be mentioned the erection of roofs, towers and balconies, the architectural style of which was not in keeping with that of the castle itself.

The severe criticism which this method of restoration incurred from the writings of Von Ouast, the curator appointed at that time, brought about a decided change. Careful archæological investigations were now instituted before work was continued on the almost ruined stronghold of the former commandery; archives were searched for documents which might give information regarding the architecture of the old castle; excavations were made which unearthed valuable relics. Only after these inquiries was work continued on the castle, and even then only under the supervision of a board of acknowledged authorities on architecture. There thus began in 1882 a second period of restoration with brighter prospects in view than the first—a period which enjoyed the firm support of Von Gossler, the present governor of the province. In Dr. Steinbrecht, the imperial architect who is at present so honorably filling his important position, was found a genius who knew how to reawaken the old life in the ruined mass.

But the completion of the task was prevented by many difficulties, chief of which was the lack of money; the consequence was the total cessation of labor between 1884 and 1886. A new spirit entered into the work when in 1885 the connoisseur crown prince, afterward Emperor Frederick III., visited Marienburg. Through his powerful influence, an annual appropriation was made by the government, together with the grant of a lottery, the income of which enabled the architects to complete their task. No longer obstructed by insurmountable obstacles, the commission continued its labors with new energy, and so carefully and systematically that architectural errors were practically excluded. The reconstruction of the best preserved corner of the chapter hall was now begun from the exterior, and it would, perhaps, be not uninteresting to ascertain how the work was conducted. Beginning from the topmost story, all additions not dating from the middle ages were carefully removed; whatever portions of the old walls still remained were propped up by wooden beams and the foundations cleared of the overlying rubbish. Beginning now from the cellar and proceeding upward, there followed a rude restoration of the walls, over which the roof and gables were then erected in their orginal forms. Again reversing the operation and working from top to bottom, the walls were improved wherever necessary and copies of the old battered form-pieces and decorations inserted in their proper places. Proceeding in the opposite direction for the fourth and last time, the arches and vaults of the various stories were reconstructed. In this manner the work progressed from wing to wing, from story to story, until finally the exterior of the stronghold, with its gate keepers' houses, its terraces and corridors, was at last completed.

Passing over a drawbridge and through a well-preserved Moorish portal that opens through the ramparts, the sightseer arrives in the inclosed court of the castle, a delightful spot, presenting an aspect of peaceful quiet. To the four wings of the castle, which rise up majestically and are overtopped by the slender main tower, there leads a cross-passage flanked on either hand by massive granite pillars and "storied windows richly dight." The lowest floor, which extends over the cellars of the vast building, contains the kitchens and storerooms, while the castle chapel, the chapter hall, the living rooms and bed chambers occupy the second story. Toward the south side of the top story are found the assembly hall and the private rooms of the nobles; the remaining wings contain the magazines and provision vaults. Narrow staircases built directly against the walls lead to a network of passages extending to all the battlements and over that portion of the castle immediately underlying the roof.

Of the whole structure, no part was in a better state of preservation than the chapel of St. Mary's. Through an exquisitely carved portal dating from 1280, one passes into the consecrated church, which forms but a single nave and is extraordinarily long and narrow. The ribs of its groined vaults gracefully bend down and merge into the half-divided columns, which are ornamented by sculptural foliage. Excellently preserved, there came down to our own time the finely proportioned gallery and the beautiful friezes, on which are carved the forms of holy men and women prominent in



THE CASTLE VIEWED FROM THE SOUTH.

* In this part of our article, as well as in other portions, we have used matter obtained from a paper read by Dr. Steinbrecht before the Society of German Architects and Engineers on the occasion of their twelfth reunion in Berlin.

the history of the Christian church. For the restoration of the pews, pavement carpets and triumphal crosses, well preserved remnants served as models.

At the present time the chapter hall is being transformed into a magnificent structure in keeping with its important character as the order's highest place of conference, in which elections of the grand masters took place and decisions rendered which affected the peace of the province. As the three ribs on the side of the vault bend down to the octagonal columns and gracefully merge into them, the eye, on beholding these three slender granite supports, likens them to palm trees. Figures on the capitals of the columns represent in symbolical form the vows of the order: Poverty, Forbearance, Obedience. The hall is further ornamented by thirteen mediæval stained glass windows. Upon the walls will be hung portraits painted in antique style of the twenty-three grand masters of the order, from Heinrich von Walpot to Ludwig von Erlichshausen, the last master in Marienburg. Richly ornamented and carved benches, gayly colored pavements and other furniture in keeping with the character of the hall will complete the harmonious whole.

The long seven-columned assembly hall, where the nobles dined together, and the triple-columned convention chamber connected therewith, are particularly cheerful rooms. Even to the present day the simple assembly hall, with its beautiful fireplace, its chandeliers of elk antlers and its old German furniture, preserves its power of inspiration. Here it was that Emperor William II. gave a magnificent banquet to his generals and the nobles of the province after his triumphal entry into the castle during the imperial maneuvers of 1894. The convention chamber is one of the most delightful portions of the castle, and similar to the chapter hall, its vaults are decorated with the escutcheons of the nobles. A platform or stage for singers, old German chests and closets, pieces of armor and other embellishments here attract the eye.

In the artistic decoration of the various halls, Dr. Steinbrecht was assisted by an advisory board of artists composed of the sculptors Prof. Behrend, of Berlin, Schöneseiffer, of Marburg, H. Schmitz, in Cologne; the painters Prof. Schaper, of Hanover, August Grinmer, of Berlin (who died in the meanwhile), and glass painter Prof. Haselberger, of Leipsic.

"Der Verein zur Wiederherstellung und Ausschmückung der Marienburg" (Society for the Restoration and Embellishment of Marienburg), the president of which is the provincial governor Von Gossler, has endeavored to give that semblance of animation to the many halls and chambers by which alone the impression of a completed task is given. In this respect an important acquisition was made in Theodore Blell's magnificent collection of weapons and in the magnanimous gift of a large collection of coins by Dr. Jacquet. Everything that in any way relates to the history of the order is eagerly brought hither, so that in a very short period valuable historical treasures will be preserved in the castle.

Viewed from the exterior, the castle of the order presents a charming picture, replete with the thoughts, the ideas and the noble spirit of the art that restored the old structure to its former splendor. A similar impression is received by regarding the castle from the river, on the banks of which there rise the central castle, grand master's palace, the tower-crowned drawbridge, the watch towers and the sconces of the citadel, together with the richly ornamented church of St. Mary, with its huge Madonna statue standing in a niche. Even as the knights of the order united the sword with the cross, so the whole structure shows a close connection of the worldly with the spiritual, of life with faith. The building was once a castle, a defense against hostile force, a residence of princes; but it was also a church, with consecrated ground, where, amid the swinging of censers and the chanting of choirs, the knights of old performed their Sabbath devotions. The old castle thus again rises before us—a stone record that tells of the flourishing state on the Baltic founded by the Teutonic Order more than six centuries ago.—Waldemar Schrey, Illustrirte Zeitung.

GENERAL LABORATORY FOR MICROSCOPY, HISTOLOGY AND EMBRYOLOGY.

LABORATORIES OF CORNELL UNIVERSITY.*

By L. B. ELLIOTT.

ALL the laboratories are abundantly supplied with compound microscopes, and also with dissecting microscopes, according to their needs, and with specimens for illustrating the various courses, and for research work, whether the forms required are native or have to be procured from a distance. The recent development of reliable depots for laboratory supplies renders it convenient and inexpensive to place before classes the most desirable material in sufficient quantity for dissection and microscopical study. The laboratories

* Abridged from the Journal of Applied Microscopy. Published by Bausch & Lomb Optical Company, Rochester, N. Y.

GENERAL LABORATORY FOR BACTERIOLOGY AND PATHOLOGY.

are all provided with their type collections of prepared slides, some for class use as guides to what a typical preparation should be, others for the demonstration of subjects too difficult for class preparation or which would not be likely to be met with in the course of the work. Small libraries are attached to all the laboratories and contain only such books as are required for actual use during the laboratory exercises, it being the policy of the university to concentrate the library in such a manner that it will be equally accessible to all. The general library is therefore the Mecca of all the special as well as the general students, and no more congenial place for study could be devised than its excellently arranged reading rooms. The special libraries are very complete for each of the groups of sciences, and great attention has been paid to current periodical literature as the basis for advanced work.

The laboratories of Microscopy, Animal Histology and Embryology, and of Bacteriology and Comparative Pathology are newly constructed and may be taken as types of properly arranged and equipped modern laboratories. They are located on the upper floor of the new Veterinary College building.

Laboratories of Microscopy, Histology, and Embryology.—The general laboratory is designed for eighteen students at one time, as a larger number cannot be given the desired personal attention. Each student is provided with a compound microscope having coarse and fine adjustment and fitted with two eyepieces, and with a low and medium power dry, and with a one-twelfth inch oil immersion objective, triple revolving nose piece, Abbe condenser, and iris diaphragm. This equipment is considered the least which should be provided for microscopical work. Each student also has a whole table to himself and is furnished with a locker convenient to his table, wherein he may keep all his accessory apparatus and supplies.

Two pieces of apparatus are always to be found on the table, a small glass waste jar, over the top of which (see figure) there is a pair of connected metal rods supporting a small metal funnel. In preparing slides they may be laid on the rods and irrigated, or staining material placed on the object. When it is desired to drain off superfluous stain or to wash the preparation, the slide is stood on end in the funnel until drained. The other article is the eye shade, consisting of a metal base formed of a small tin dish filled with lead, into which a wire bent at right angles at the top is inserted. Upon the bend of the wire is hung a sheet of common manila paper of such a length that it shall be just above the stage of the microscope. As the student sits facing the light, the eye shade is placed in front of the microscope and excludes the light both from his eyes and from the upper surface of the object.

Each microscope owned by the laboratory has a separate locker with combination lock. The microscope lockers are all contained in a large cabinet which in turn has heavy doors with safety locks. One or two students, as the case may be, are assigned to use one microscope, and to them only is given the combination of the lock securing the instrument.

The sink, shelves of reference books, and chemicals are centrally placed so as to be equally accessible from all parts of the room. The chemical shelves are arranged on either side of a niche containing a small balance, so that the student may select and measure out at once the exact amount of material required, and that it shall be done at that one place only. At the lower end of the room a special table supports a large paraffin bath, containing twenty-four separate drawers, one for each student. This bath is kept running at a constant temperature, the students not being required to attend to it. One table is provided with Bunsen burners and supports for heating dishes, also the paraffin cans. All processes which require heat are done here only. The microtomes are placed on a separate table and all sectioning must be done here.

There is a complete photographic laboratory which may be used from either of the general laboratories on the floor and which contains all the necessary apparatus and chemicals for developing, printing, and finishing the prints. The simplicity and practical nature of this whole arrangement is best seen when the laboratory is in use. When the students enter, the room is entirely clear, not a bottle or dish in sight except the small glass waste jar and eye shade on each table. It is, however, but the work of a moment for each to open his locker, secure microscope, reagents, and material, all of which are placed on the work table, and commence work. At the end of the period a scarcely longer time is required to replace the apparatus on the reagent boards and put them in the lockers again, leaving the laboratory as clear as before, no misplaced articles, no apparatus exposed to dust and danger of breakage, and above all the habit of "method" instilled into even these well grown pupils.

This is one of the few laboratories in the country where it is deemed necessary to teach the student the proper use of his tools before he is given journeyman's work to do, and one of the still fewer number in which will be found an accessory equipment adequate or planned for the purpose of demonstrating the points which the student will be required to know in order to do intelligent work with the microscope. The course in the practical use of the microscope extends over five weeks, consists of lectures and laboratory work, and forms the basis for all the other courses in which the microscope is used.

The idea is to have the student actually do all of the

LABORATORY TABLE

operations necessary for practical work and to give him such information that he will be able to strike out independently and intelligently in any direction in which his investigation may subsequently lead him.

The research laboratory is provided with the same kind of tables, stools, and lockers as the general laboratory, also special table for Bunsen burners, etc. The microtome is one of the most used instruments here, and the table in the middle of the room is provided with two of the most complete instruments obtainable, one for serial work, the other for collodion sectioning and cutting large pieces of tissue and large objects. The assistant professor's roll top desk and revolving bookcase occupy a quiet corner. A large aquarium with a constant supply of running water furnishes living material. The card cabinet and cabinet of prepared microscopic objects is also found here, the latter containing the especial series illustrating the more difficult problems considered.

As the collection grows it classifies itself, new specimens being recorded on cards already containing the record of similar material or adjacent to it, and being assigned adjacent positions in the trays.

The card cabinet is also used for bibliographical purposes and for recording the results of observations and all kinds of information.

The Bacteriological and Pathological Laboratories.—The special features of the general bacteriological laboratory are the incubator room with its three large incubators for pathogenic and special cultures. (All connections between the incubators, sterilizers, and burners and the gas supply are made by means of small lead pipes. This pipe offers the advantage over rubber hose that it does not rot out and does not permit the escape of gas into the air. In case of a burner lighting back, the lead pipe will not burn as rubber would. The connection between the lead pipe and the gas pipe or burner is made by means of rubber tubing, and where burners are to be moved about, the rubber tube can be a foot or so long.) The student's everyday cultures are kept at the proper temperature in a gigantic incubator which stands in the work room. Each section has its own shelf in the incubator, and each student's cultures, be they few or many, are kept in an easily sterilizable tin receptacle specially provided for that purpose. Each work table has a Bunsen burner with by-pass, so that the flame may be shut off with the exception of a small side flame, which ignites the main flame by simply turning the valve open. There are several large hot air sterilizers all grouped under the hood. The steam sterilizers are of special construction and of ample size for the accommodation of the sterilizing receptacles of an entire section.

HOOD FOR STERILIZERS, SLATE-TOPPED WORKING TABLE AND GENERAL REAGENT CASE IN BACTERIOLOGICAL AND PATHOLOGICAL LABORATORY.

The nivellating table is designed to take the place of the usual forms of nivellating apparatus, as it is itself perfectly level, is provided with several shelves divided into compartments, the whole being covered with a glass hood, excluding dust but not light. The area in the middle of the room is occupied at one end by a large slate-topped table with a large water bath, and at the other by a revolving bookcase holding the standard reference works, two reading tables, and chairs. The work in this laboratory is of the most practical character. Each day's work is definitely outlined, and reference sheets giving explicit directions for every operation which the student is expected to perform are supplied. The general course of the work is outlined in a general lecture covering several days of laboratory work. The student is taught from the first the importance of a thorough knowledge of the apparatus which he is to use and the importance of the scientific care and cleansing of it. The microscopic equipment is the same as in the microscopic and histological laboratories, and the most of the students have had their preliminary training in the use of the microscope there. The research laboratory has a roll top desk and revolving bookcase for the assistant professor, lockers, tables, stools, microtome table, sink, etc., as in the laboratory "A" described. There is in addition a full set of incubating and sterilizing apparatus, including a large autoclav. The professor's room is divided by a partition into an office room with desk, bookcases, card and specimen cabinets, and tables, and a private laboratory fitted up with all the apparatus necessary for the culture and study of bacteria and allied forms.

While this article deals especially with the laboratories of plant and animal histology, bacteriology, and pathology, it should be said that excellent laboratory facilities are also offered in entomology and invertebrate zoölogy, in vertebrate zoölogy, in mineralogy and petrography, in physics, and in chemistry. Naturally, however, the work in those departments, except perhaps entomology, is not so largely microscopic.

TUBERCULOSIS AND VINEGAR.*

By JOHN ASHBURTON CUTTER, B.Sc., M.D., New York City.

IN the bibliography appended, much of which is from the publications of this association, I show what has been done by an American writer.

BIOLOGICAL.

The morphology of the blood in health is as follows:

"Color.—Bright, fresh, clear, ruddy, strong. Clottings, rapid and firm.

"Red Corpuscles.—Arrange themselves in nummulations or are scattered evenly over the field; normal in size; non-adhesive; central depression well marked on both sides; periphery well rounded, clean cut. Hold coloring matter firmly. Pass readily to and fro through the fibrin filaments. Appear fresh and fair.

"White Corpuscles.—Normal in size, not enlarged by internal collections of foreign bodies. Ameboid movements strong or not. Proportion, 1 to 300 of red corpuscles. Consistence good, not sticky. Color a clean white. Freely moving at will.

"Serum.—Clear and free at first sight from any form. After fifteen minutes, most delicate semi-transparent fibrin filaments appear, forming a very light network in the field, which offers no obstacle to the passage of the corpuscles."

The morphology of the blood in tuberculosis is as follows:

"First or Incubative Stage.—Red blood corpuscles are less in number, ropy and sticky more or less, but not much changed otherwise.

"Second Stage of Transmission.—1. Red corpuscles: Color pale, non-lustrous; not clear cut, not ruddy. Consistence sticky and adhesive. Coating of neurin removed. Not so numerous as in normal blood. Owing to the increased size and strength of the fibrin and the stickiness, they form in ridges, rows, but not so marked as in rheumatic blood. They accumulate in aggregations of confused masses, like droves of frightened sheep. They adhere to each other, and are rotten, as it were, in texture. 2. White corpuscles: enlarged and distended by the mycoderma aceti, or spores of vinegar yeast, that are transmitted into the blood stream from the intestines. 3. Serum more or less filled with the spores of mycoderma aceti or vinegar yeast. These occur either singly or in masses of spores, which is the common form in which they are found, wherever vinegar is produced. The fibrin filaments are larger, stronger, more massive, than in health, and form under the microscope a thick network which is larger, stronger and more marked in direct proportion to the severity of the disease or the amount of accumulation. Besides, the serum is apt to be of a dirty ash color. The sticky white corpuscles, the massive fibrin filaments in skeins, and the yeast spores alone or combined, form aggregations, masses, collects, thrombi and emboli which block up the blood vessels of the lungs soonest, because exposed to cold air the most of any viscus; the blood vessels contract and thus arrest the thrombi and form a heterologous deposit, which is called tubercle.

"The Third Stage of Tubercular Deposit.—These deposits increase so long as vitality subsists in the tubercle and surroundings. When vitality ceases, the tubercle softens or breaks down. Sometimes, if the process is very slow and life slightly inheres in it, the proximate tissue undergoes fatty infiltration which preserves it from readily breaking down. The morphology of the blood is the same for the second and third stages of consumption.

"Fourth Stage, Interstitial Death.—The red corpuscles are thinner, paler, much lessened in number, increased in adhesiveness, stickiness and poverty; devoid more or less of neurin. The white corpuscles are fewer in number, more enlarged, often ragged and rough. Distended with spores of mycoderma aceti; more adhesive and sticky. The serum: fibrin filaments are thickened, stronger, more massive, and more skeins of

* Abstract of a paper presented to the Section on Physiology and Dietetics, at the forty-eighth annual meeting of the American Medical Association, held at Philadelphia, Pa., June 1-4, 1897.—From the Journal of the American Medical Association.

them present. The collects of mycoderma aceti are very much larger and more numerous. In moribund cases I have seen them so large as almost to fill the field of the microscope."

PRE-TUBERCULOSIS.

"The idea that diseases have periods of incubation preceding their full development accords with other facts in animal and plant biology. It is to be expected that tuberculosis of the lungs, for example, has a pre-stage. In fact, pre-tuberculosis exists, and clinically means that the morphology of consumptive blood is present to a lesser extent than in tuberculosis, that the essence of pre-tuberculosis is in these vegetations in the blood, which, coming from the fermentations in the alimentary canal, pass the barriers of the intestinal epithelia and float about in the blood stream of consumption any time during one year before the necrosis or sphacelation or breaking down of the lungs, sufficient to be detected by the usual signs, furnished by auscultation and percussion. It is evident that in such spongy bodies as the lungs small deposits may escape physical macroscopic exploration. But the microscope will detect this stage."

VINEGAR AND HOG CHOLERA.

"Seven years ago my son and I independently studied hog cholera, on a large stock farm in Western Massachusetts, autopsying animals immediately after death: 1, by the disease, and, 2, by slaughter in early and late stages of complaint, the proprietor giving us every opportunity of macroscopic and microscopic examination of blood and tissues of his animals, as he considered his herd doomed. We found, independently: 1, the blood morphology of tubercle and embolism; 2, tuberculosis of lungs, bowels, skin; 3, recent fibrin clots in the heart; 4, partial paralysis of hind extremities; 5, paralysis of nerve centers.

"Causation of this Epidemic.—1, Steady feeding of ensilage which is loaded with vinegar and vinegar yeast; 2, swill food brought from outside; 3, cold weather; 1 and 2, predisposing causes; 3, exciting cause."

The hog physically is much like man; man is very much of a hog as to eating food that makes swill, and hence suffers much from tubercle.

WORLD-WIDE RELATIONS.

The Esquimau does not die of tuberculosis. He lives on animal food, yet for months of each year he breathes a vitiated atmosphere.

Tuberculosis ravages in the South, where little good beef is eaten and instead very much of vegetable food. Some fifteen years ago a resident of Savannah, Ga., came under treatment in New York. He changed his mode of living and became a beef eater. Since that time all of his family have died of tuberculosis; he lives because of his beef-eating habits. The negro dies of tuberculosis. Causes, poor food, the mental strain of trying to reach the white man's level, and syphilis, with its grandchild scrofula, and tubercle.

Tuberculosis has ravaged in New England, especially the rural portion, with its diet of pie three times a day and baked beans, which latter, chemically, are splendid food for cattle, but for man not fit, unless cooked for many hours. Tuberculosis is now diminishing in New England because they are eating more beef and drinking more milk, although there has been very much foolish opposition to the use of milk.

Cattle are dying in New England and other places of tuberculosis, and so long as the silo, with its alcoholic and vinegary products, is used, so long will farmers lose their cattle. A man imported a splendid herd from the island of Jersey some fourteen years ago. He had a silo. He was expostulated with as to the dangers of feeding sour foods to his cattle. He persisted, and all died of either tuberculosis or heart disease.

The easiest way to exterminate the Indian is to give him plenty of white flour and rum. Tuberculosis always follows.

There is no "royal road" to the cure of tuberculosis or its prevention. The various tuberculin treatments are based on the principle of injecting an attenuated dose of poison into the human system, and this poison, like strychnia and many other drugs, stimulates nature, and, in some lines by inflammation, to cure the diseased lungs and joints. One that has been afflicted with cough, weakness, emaciation, pain and dread of impending death, would only too eagerly accept such a treatment. Yet in its very best it only effects results, it does not touch causes, and when one sees men like Robert Koch wrestling on this line, while lives go out because they will persist in ignoring the causative relations of vinegar and vinegar yeast to tuberculosis, it makes one wonder at this neglect of general principles. So long as the cause is being put in the system, so long will tuberculosis continue, and it is strange that these followers of Koch also ignore the positive relations of syphilis and scrofula to consumption. As far as I can learn, the majority of medical men are using, as a basis of their treatment, animal food, but why should they gravitate to the other side and give the causes of the disease, to wit: fermented milk foods, such as kumyss, etc., pastry, starches, sugars, vegetable foods of many kinds, that cannot digest, because of the weakness of the bowels, salads that soon make swill, jellies and colloids, to name no more? These same men also neglect the value of the study of the morphologies of the blood, sputum, feces and urine, as laid down by American observers.

At whose door shall be laid the blame of the ignoring of the incalculable value of the diagnosis of the pretubercular state, which diagnosis can be made before the lungs are affected, and before there is any sputum to find bacilli in or diseased spots in the lungs for tuberculin to react on? This knowledge of the pretubercular state is of the greatest value to humanity of anything in the practice of medicine.

The Dr. Cyrus Edson treatment was based on so-called logical grounds as to certain relations of carbolic acid to the human body in tuberculosis, yet he adds pilocarpine to his remedy to stimulate white blood corpuscle activity. He therefore indirectly recognizes the presence of vinegar yeast in the blood and that anything which helps the action of white blood corpuscles will help the patient for a time. Why not put the ax to the root of the tree, and stop the formation of this vinegar yeast in the blood?

Some Europeans are now using raw beef. Why they do not give their patients broiled beef I cannot understand. Raw beef is unpalatable, it promotes tape worm. The use of beef is the bottom principle in the treatment of tuberculosis, but it should be employed in the form of steaks or roasts, or the first class top of the round freed from connective tissues by machine or knife and chopping bowl, as the connective tissues are of a colloid nature, and ferment, and tend to the production of vinegar yeast. The lean muscle pulp is then moulded into a cake, an inch and a half deep, several inches wide, not too tightly pressed together, and in all of its preparation care should be taken to touch as little as possible the meat direct by the hands, as the human animal heat will change the character of the muscle pulp; broil this over a bed of good live coals, a gas stove or even kerosene flame, turning often, and the resultant should be of a dark brown color on the outside and of a reddish but not raw appearance inside. It is best served on a hot water plate, and if a little underdone, it will cook on the plate when the meat cake is opened. If a hot water plate cannot be obtained, one can be extemporized by the use of a soup plate filled with hot water on which is placed another plate with the meat. There cannot be too much care used in the buying of the beef or its preparation, and if proper caution is taken, the patient will generally eat it with a relish. It should be seasoned with pepper, salt, butter, Worcestershire sauce, horse-radish, lemon juice, as the patient desires.

Lamb, mutton, the dark meat of fowl and game, broiled codfish, can be used as changes; the whites of eggs dropped in boiling water and slightly cooked may be taken freely if the patient is not eating enough of solid food. Some patients will take the whites of from one dozen to two dozen eggs in a day when weak and not able to take other food. Don't do as one woman did; she gave her husband the whites of eggs dropped in boiling water with plenty of vinegar. The masses of vinegar yeast in the blood were so large and frequent under the microscope that amazement was expressed. The woman protested that she was doing everything absolutely according to order for her husband. As all of his symptoms were worse because of this blood morphology of the masses of vinegar yeast, it was insisted on that some error was being made, and it was ascertained what she had done.

Vegetable food may be added as follows: Some patients can bear one of the following foods at a meal —cracked wheat, rice, hominy, toasted entire wheat flour bread, baked potato. It is a hardship at the best to confine patients to close diet, and physicians should give them as much variety as possible, but there is more danger of error on the one side of too broad a diet than one of too narrow. The use of distilled water or some good spring water that has not more than five to ten grains of salt to the gallon should be persisted in, drank (after boiling) at a temperature of from 100° to 120° F. one hour before each meal and on going to bed.

Medicines should be employed in the treatment of tuberculosis on principles, and the main one is to give no medicine which can ferment into alcohol and vinegar in the alimentary tract. This principle forbids the prescribing of many cough sirups and other preparations now largely used.

The skin in tuberculosis is more or less loaded with the vegetations of vinegar yeast. There should be employed daily sponge baths. The water to be hot or cold according to the patient's desires. Ammonia and water in the proportion of two teaspoonfuls to a pint, or the aromatic sulphuric acid one teaspoonful to a pint, or even the nitro-muriatic acid, one-half teaspoonful to a pint, can be used with great advantage; rubbing with a saturated solution of spirits and salicin is a good means of toning up the skin and the whole body.

Bacteria or bacilli are babies of vegetations which have become animalized by contact with the human body and human secretions. Robert Koch demonstrated their presence in the sputum of tubercular cases, for which he should receive due credit, but the work which antedates his in time and importance as showing the real cause of tuberculosis must not be ignored. The vinegar yeast found in the blood is the second stage of the bacteria, and is found there in the spore form, and sometimes in tubercular cavities we get the third stage of development in the aerial filaments of the vinegar yeast.

Physicians could learn more as to relation of sour foods to tuberculosis in a few months' time by experimenting on hogs (not guinea pigs or rabbits), by feeding a certain number with sour and a certain number with sweet foods, having all in the same building, so that they breathe the same air. The beauty of this kind of work is that one can kill the animals any time one pleases and know just what is going on.

The agricultural experiment stations of the different States are fully equipped to make these investigations on hogs. It is necessary, however, that the microscopist who follows the experiments should have a fair working knowledge of the methods of the American observers who have been studying this subject for nearly thirty years on their patients and with animals. If it is right to rush abroad to Berlin to study cured cases of tuberculosis, some of whom die the day after they are pronounced cured, there can be no harm in studying in America all the work which made cured cases twenty-five years ago, for such cases are living now.

PROGNOSIS.

Granted a recognition of the relation of vinegar to tuberculosis, the prognosis can be more definitely made out, for if one is stopping a cause, then one has some hope to base his belief of cure on. If one is simply treating results according to tuberculin methods, and is still putting in the food which will undergo vinegary fermentation, the prognosis must necessarily be doubtful.

What is the experience of those who recognize the relation of vinegar and tuberculosis? Temperament here comes in. Some of the most appalling cases, with many hemorrhages, with the evidence of cavities in both lungs unquestioned, as determined by physical examination of the chest and by the detection of the elastic and inelastic lung fibers in the sputum, have progressed most favorably under proper treatment. Others, who apparently had little disease, went down to death. The rule has had to be laid down that all cases except the moribund should have a chance for treatment. It is a most wonderful thing how nature endows these cases with hope. Some patients fight indomitably, and contrary to expectations they get well. It is not pleasant to look back and consider the amount of opposition which was placed in the path of those who twenty-five years ago were endeavoring to help these distressed patients.

But what will you do with cavities? The post-mortem evidences of many morgues and dissecting rooms show unquestionably that cavities do heal over and patients live to die of another complaint. My own wife showed three small cavities healed in the top of the left lung and two in the right. There was some fatty and calcareous degeneration going on in the base of the left lung; liver somewhat enlarged but normal in structure; no tuberculosis of stomach or bowels; heart normal in size and as to structure; yet all her symptoms for three years had been of heart exhaustion, needing the greatest care and attention. Seven years before her death an eminent medical man stated that she had but three months to live. If her appetite for beef foods, and, in fact, for practically all other foods, had not failed three years before her death, she would probably have lived to old age. Of great courage, good judgment, she in her weakness for many months traveled close to the verge of the grave. Of strong affections, her love for her dear ones kept her alive a long time; yet something in her nervous system broke down as to appetite, and her time eventually came.

It is cruel to take away from the very sick hope. There are many doctors of eminence and influence who literally are executioners because of their brutally taking away all hope. The passionate, anxious, eager holding on to life of the very sick is a matter of divine origin, and I do not propose to stand in the way of that divine gift of the desire for life.

Some patients die from money troubles. Others die from the long continued opposition of their friends, relatives and medical men to treatment. It can be thankfully said that this opposition is dying out. Others die because they are associated in herds at the various resorts in the mountains of the South and West, and in sanatoria seeing and hearing the consumptives all about them. Such suffer for the privileges of home. They have many comforts taken from them and are liable, in going South, of getting into a blizzard and have to live in a shelter which is improperly made.

I wish to emphasize that the treatment of tuberculosis must depend upon the family physician. It should commence in infancy; the children should be properly fed and taught to avoid sweets and the vegetable foods which do not agree with them, and those who are so unfortunate as to break down with the disease must still be kept at home, or such change of air and climate made as can do good and no harm. There is no question that good air is a wonderful thing, yet we can buy oxygen and force the air alimentation if necessary in our cities.

PARTIAL BIBLIOGRAPHY.

Ephraim Cutter, M.D., LL.D.

1. Treatment consumption by animal food. Boston Journal Chemistry, January, 1876.
2. See same, November, 1879.
3. See Michigan Medical News, Detroit, November, 1879.
4. Ditto, April 10, 1880.
5. Transactions American Medical Association, 1880; contributed histories of seventy cases, in one-third of whom disease apparently permanently ameliorated; this conclusion borne out by lapse of seventeen years as far as now known.
6. Tubercle parasite. Am. Med. Weekly, May, 1882.
7. Feeding against the appetite. Medical Register, Philadelphia, April 2 and 9, 1887.
8. Food versus bacilli. Open letter to Dr. John A. Cutter, my son, with answer. Virginia Medical Monthly, Richmond, December, 1888.
9. Vinegar and vinegar yeast. Times and Register, Philadelphia, July, 1889.
10. Food and tubercle. International Med. Congress, Berlin, 1890.
11. Feeding in the wasting diseases. Joint report to Committee of Dietetics of Am. Med. Association, 1890, with Dr. John A. Cutter. Journal of Amer. Med. Association, July 26, 1890; Med. Bulletin, June, July and August, 1890; N. E. Med. Monthly, August, 1890; Pac. Med. Jour., August, 1890; Southern Practitioner, July and August, 1890; Virginia Med. Monthly, June and July, 1890. On (I) Consumption, one hundred cases; (II) Bright's disease, fibroid tumor and cancer; (III) Male neurasthenia.
12. Ameboid movements of the white blood corpuscle. Boston Journal of Chemistry, June, 1876.
13. Hog cholera; its cause known. Western Rural, March 22, 1879.
14. Morphology of diseased blood. Southern Clinic, March, 1879.
15. Tolles' one seventy-fifth inch objective; its history, uses and construction. Am. Journal of Arts and Sciences, New Haven, August, 1879; Scientific Am. Supplement. Translated into French, and published, Journal de Micrographie, Paris, 1879.
16. Some details as to Tolles' 1-75 objective. The Am. Monthly Microscopic Journal, August, 1895.
17. Primer of the clinical microscope. Virginia Med. Monthly, August and September, 1879. Pamphlet.
18. A new physical sign on the pretubercular state. Ready since 1877. Illustrated.
19. Pretuberculosis. Am. Monthly Microscopic Journal, May, 1895.
20. Leavens and Man. Written by invitation of, and for the Philosophical Society of Great Britain, 1884. Many original illustrations.
21. Morphology of syphilitic blood. Am. Journal of Dental Science, October, 1879. Reprint.
22. Food as an esthetic, chemic, physiologic, pathologic and therapeutic. Am. Journal of Dental Science, January and February, 1880.
23. Abnormal entozoa in man. Virginia Med. Monthly, February, 1881.
24. Use of the microscope in consumption. Diagnosis of necrosis and disintegration. First paper. Journal of Microscopy, Phin's, September, 1881.
25. Second paper. Necrosis of lung. Differential diagnosis. Am. Journal of Microscopy, Phin's, 1882.
26. Tubercle parasite. Editorial. Scientific American, June 2, 1882.

27. Ice morphology. Scientific American Supplement, 1885.
28. Partial syllabic lists of the clinical morphologies of blood, sputum, feces, urine, foods, clothing, soiled, etc. Book. Published by author, 1888.
29. Use of the microscope. Book, not published, 1874.
30. The esoteric beauty and utility of the microscope. The Journal of the American Medical Association, May 7, 1892. The Microscope, January, February and March, 1892.
31. Note on consumption. Philadelphia Med. and Surg. Reporter, May, 1881.
32. Uterine diseases sometimes called consumption. Transactions Medical Association of Georgia, 1880.
33. The therapeutic drinking of hot water; its origin and use. Am. Med. Weekly, January 8, 1883; Druggists' Circular, August, 1883; London Lancet, September 15, 1883; Journal d'Hygiene, October 25, 1883; Therapeutic Gazette; Scientific American; Constitutionnelle, and the medical and secular press of Paris.
34. Colloid disease. Alabama Med. and Surg. Age, March 3, 1889.
35. Under what circumstances do the usual signs furnished by auscultation and percussion prove fallacious? Boylston gold medal prize essay, 1857.
36. The American blood test for cattle tuberculosis. The New England Medical Monthly for July, 1896; American Monthly Microscopic Journal, 1896.
37. Medical food ethics; now and to come. Secretary's address before Section on Physiology and Dietetics, Am. Medical Association, 1862. The Journal of the association, 1893.
38. Reprint, 1897, food and tubercle. Transactions Tenth International Medical Congress, Berlin, 1890. Band Abtheilung v., p. 30. The present excerpt being an addendum to the original 1890 article.
39. Preventive medicine and tuberculosis. The Journal American Medical Association, 1897.

LINDE'S METHOD OF PRODUCING EXTREME COLD AND LIQUEFYING AIR.

By Prof. J. A. EWING, F.R.S., M. Inst. C.E., in the Journal of the Society of Arts.

IN May, 1895, Dr. Carl Linde, of Munich, whose earlier services to refrigeration in the development of the ammonia compression machine are widely known, made public a novel process which he had invented for attaining extremely low temperatures and for liquefying air. By his method the production of liquid air is so much simplified that its application to industrial uses is comparatively easy. Industrial uses are in fact now being found for the process, and at Dr. Linde's request I have undertaken to bring it before the Society of Arts and to speak briefly of the applications to which it is now being or about to be put. The inventor's son, Dr. F. Linde, has come from Munich to exhibit the apparatus in action.

From the industrial point of view the liquefaction of air is likely to prove valuable mainly because it gives a means of separating more or less completely the oxygen of the atmosphere from its associated nitrogen. When air is liquefied it is noticed, as Prof. Dewar has remarked, that both constituents liquefy together, so that the act of becoming liquid does not contribute to separate them. But when liquefied air evaporates, the nitrogen evaporates faster than the oxygen, for it boils at a temperature which is about 13° C. lower than the boiling point of oxygen. Hence the mixture of liquefied gases becomes richer and richer in oxygen as the process of evaporation goes on. By letting a considerable part of the liquid evaporate, a liquid remainder is left which may consist largely of oxygen; and by letting this remainder evaporate an atmosphere rich in oxygen is obtained.

Dr. Linde has given me the following figures, deduced from his own experiments, which show how the constitution of the liquid changes during slow evaporation. In the table, m is the percentage of the whole liquid which remains at each stage in the evaporation; a is the percentage of oxygen in it; b is the percentage of oxygen in the vapor then coming off, and n is the percentage of the original quantity of oxygen which still remains in the liquid.

m Per Cent. of Liquid not yet Evaporated.	a Per Cent. of Oxygen in Liquid.	b Per Cent. of Oxygen in Vapour coming off.	n Per Cent. of Original Oxygen still in Liquid.
100	23·1	7·5	100
50	37·5	15	80
30	50	23	65
20	60	34	52
15	67·5	42	43
10	77	52	33
5	88	70	19

These results are also given in the curves of Fig. 1.

Thus, for example, by the time 70 per cent. of the liquid has disappeared in quiet evaporation, the remainder (viz., 30 per cent.) contains 50 per cent. of oxygen. The gas then coming off contains 23 per cent. of oxygen. And out of the whole quantity of oxygen which was present in the original liquid 65 per cent. is still there. I understand these figures were obtained by examining the proportion present in the gas given off at each stage; in other words, the points in the curve, b, were found by experiment, and the other quantities were deduced by calculation from these.

It is only when evaporation is going on very quietly that these results hold good. Anything like violent boiling has the effect of carrying off the oxygen more rapidly, and consequently of preventing, to some extent, the enrichment of the residual liquid. When this method of separating oxygen from nitrogen is carried out on a commercial scale, the evaporation cannot well take place so quietly as it took place in these experiments. Dr. Linde tells me that when working under practical conditions he has to allow about four-fifths of the liquid to evaporate in order that the residue shall contain 50 per cent. of oxygen. Even then, however, some 40 to 45 per cent. of the original oxygen remains in the unevaporated liquid.

Before going on to speak of the uses to which the oxygen procured in this way may be put, the process itself must be described. In all methods of liquefying a gas the first essential is to reach a temperature lower than the critical temperature of the gas. For air this temperature is about −140° C. Such a temperature, or one still lower, may be reached by evaporating liquid ethylene in vacuo, and hence air may be liquefied by compressing it into a surface condenser, which is cooled by the evaporation of liquid ethylene, while the vapor of the ethylene is removed by a pump. A separate compressing pump restores the ethylene vapor to the liquid state by compressing it into another condenser, which is cooled by the evaporation of liquid carbonic acid, and that again is compressed by a third pump into a third condenser, which is cooled by circulating water. Such a cascade, as it may be called, of pumps and condensers furnished (previous to Dr. Linde's invention) the only practicable method of liquefying air in any considerable quantity, and it was by means of apparatus such as this that Prof. Dewar carried out his remarkable experiments which have made the laboratory of the Royal Institution pre-eminently the home of liquid air.

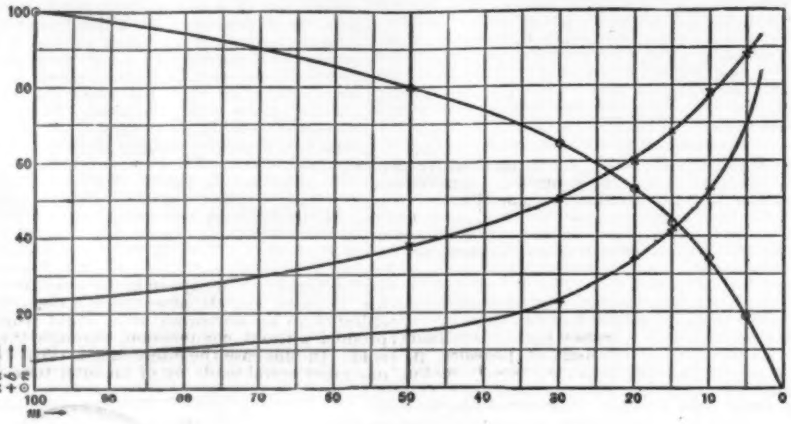


FIG. 1.

Dr. Linde's method is entirely different from this. It is a regenerative method; that is to say, the cold produced by the treatment of one portion of air is communicated to the portion which is next coming on to be treated, and so on, with the result that a cumulative cooling proceeds, which is only limited by the leakage of heat into the apparatus from outside.

Imagine air, or any other gas, to be pumped round and round a closed system of pipes, and imagine that at one place in the system it suffers a drop in temperature through some internal action. Imagine, further, that the air which has suffered this drop in temperature is led back to the pump through a pipe, which is brought into close contact with the pipe conveying air from the pump. It consequently cools the air, and that in its turn suffers a further drop, and cools still further the air that is next coming on.

The two factors in this regenerative process are (first) the interchanger of heat between the going and coming air, and (second) the step-down or drop in temperature, in consequence of which the air that is going away is always colder than the air that is coming on.

There are two ways in which the step-down or drop in temperature, which is essential to the action, may be produced. One way is to let the air coming under pressure from the pump expand in a cylinder doing work on a piston while its pressure falls. That is the way in which the cooling effect is produced in an ordinary refrigerating machine, using air as its working substance.

As early as 1857 Sir William Siemens proposed to combine a regenerator or heat interchanger with an expansion cylinder, so that the drop in temperature caused by expansion should be communicated to the incoming air, and thus the working should, as he said, "produce an accumulated effect, or an indefinite reduction of temperature." And more recently the same idea has taken practical shape in the patents of Solvay and of Windhausen, and in the experimental apparatus used in his cryogenic laboratory by Prof. Onnes, of Leyden. In all these cases the drop was produced by the use of a cylinder, which allowed the air to do mechanical work as it expanded.*

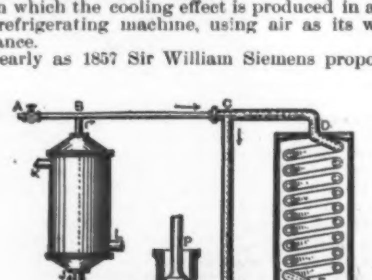


FIG. 2.

But there are serious obstacles to an "indefinite reduction of temperature" by such a device; and, in fact, Solvay found that he did not succeed in getting below about −95° C. For one thing, the mechanical difficulty of working a piston at an extremely low temperature is formidable; and further, its friction develops heat just where heat is not wanted, and the bulk of the cylinder necessarily involves a large leakage of heat from outside.

There is, however, another way of producing the necessary drop in temperature, and by using it Prof. Linde has made practicable the regenerative method of producing extreme cold. In his apparatus the drop in temperature is effected by letting the compressed air stream through a small orifice, namely, a nearly closed throttle valve, from a region of high pressure to one of much lower pressure. If air were a perfect gas, in the thermodynamic sense, it would suffer no drop in temperature when it expands in this way without doing work. Indeed, Joule in his early experiments on this subject detected no cooling, and it was only in the more delicate investigation which he made later in conjunction with Lord Kelvin that a small amount of cooling was observed and measured. Kelvin and Joule found that when compressed air expands by passing through a constricted orifice, its temperature falls by about a quarter of a degree for each atmosphere of difference in pressure between the two sides of the orifice. This is at ordinary temperatures; at low temperatures rather more cooling occurs, for the gas is then less nearly "perfect." An effect so small does not at first sight appear promising as a means of reaching extremely low temperatures, but Linde has shown that it is enough to furnish the step-down necessary in a regenerative process. The gas, cooled slightly by passing the orifice, gives up its cold to gas which is approaching the orifice. The passage through the orifice cools that gas further, and so on, with the result that a cumulative cooling proceeds. When the step-down is effected in so simple a manner, it is comparatively easy to insulate the apparatus, and to reach an extreme of cold greatly lower than could be reached if an expansion cylinder were used. A temperature of −200° C. or lower is attained without difficulty; whereas with an expansion cylinder a practical limit was found at −95° C.

Fig. 2 shows the organs of Dr. Linde's apparatus in its simplest form; P is the pump which delivers highly compressed air first to a water cooler, J K L, to remove the heat generated by compression. The compressed air goes on through the inner of two pipes forming the spiral interchange, D E, and escapes through the throttle valve, R, into the chamber, T, suffering a drop in temperature. It leaves the chamber at F and returns to the pump through the space between the inner and outer tube of the interchanger, so that the gas coming down inside the inner tube is cooled before it reaches the throttle valve. In his earliest experiment, made in May, 1895, Linde used no preliminary cooling of the air, but succeeded, after fifteen hours' continuous working, in getting so great an accumulated cooling effect that liquid air began to gather in the vessel, T, from which it could be drawn off by a tap. Any removed in this way, or lost by leakage, is

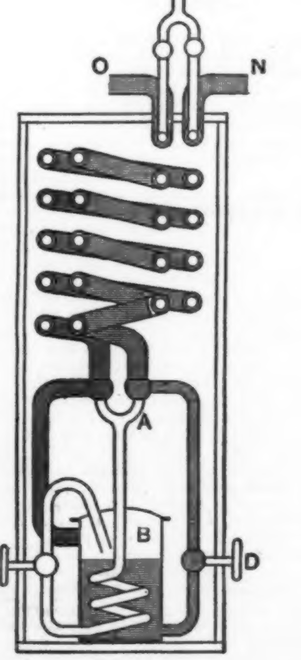


FIG. 3.

* It should be added that on May 23, 1895, Mr. William Hampson lodged a provisional specification for "improvements relating to the progressive refrigeration of gases," in which the use of a heat interchanger is described, but without making it plain in what way the patentee intended to produce the drop in temperature.

made good by pumping more in through the stop valve at A, by means of an auxiliary pump.

Another arrangement of the apparatus, designed to yield an atmosphere rich in oxygen, is shown diagrammatically in Fig. 3. There the interchanger is divided into two parts, down which the compressed air streams in parallel through the two inner tubes which converge at A. It goes on through a worm in the receiver, B, to the throttle valve, C, and is there discharged into the receiver. The gas which is given off from the surface of the liquid in B is mainly nitrogen, and it passes off through one of the two interchangers. The liquid that is left in B becomes rich in oxygen, and is allowed to drain slowly through the valve, D, and then to evaporate through the other interchanger. Thus the gas which passes off at N consists mainly of nitrogen, while the gas that passes off at O consists largely of oxygen, and forms the useful product of the apparatus. Both gases as they escape through the interchanger give up their cold to the incoming compressed air, and leave the apparatus at a temperature which is only a few degrees lower than that at which the air enters.

In cooling a gas by making it expand through a constricted orifice, the amount by which the temperature drops is proportional to the difference of the pressures, p_2 and p_1, on the two sides of the orifices. But the work which the pump has to do in forcing the air to pass again and again round the cycle depends not on the difference but on the ratio of p_2 and p_1. Hence, to make the system efficient, what is aimed at is a large difference, $p_2 - p_1$, but a small ratio $\frac{p_2}{p_1}$. This requires that p_2 should be high and p_1 moderately high. Dr. Linde accordingly makes the upper limit of pressure, p_2, about 200 atmospheres, and in some cases he makes the pressure on the other side of the orifice as much as 50 atmospheres. Thus a drop of 150 atmospheres is then associated with the very moderate value of four for the ratio of p_2 to p_1. On the other hand, if in passing the orifice the pressure of the gas were allowed to fall to that of the atmosphere, the drop on which the cooling effect depends would be increased from 150 to 199, but the ratio on which the work depends would be increased to 200. The cooling effect would be only one-third greater, whereas the work to be done by the pump, which varies as the logarithm of this ratio, would be nearly four times as great in the second case as in the first. The efficiency of the process is therefore nearly three times greater in the first case.

Even after the apparatus has become fully cooled down, and has attained a uniform régime in its working, only a small portion of the air that passes through the orifice is liquefied; the greater part returns to the pump to be compressed and sent through the orifice again. Hence it is important to maintain a comparatively high back pressure, p_1, for the greater part of the gas, and only to allow the portion that is to be withdrawn from the apparatus to fall to atmospheric pressure. This is done in Dr. Linde's newest apparatus, in the manner shown in Fig. 4, which illustrates the laboratory form now exhibited in action.

There are two throttle valves, a and b. All the compressed air passes through a, but only a small proportion (about one-fifth) passes through b. The passage through a causes a drop in pressure from 200 atmospheres to 16 atmospheres, and four-fifths of the air in circulation passes back at that pressure through the middle one of the three tubes composing the interchanger to the pump, d. The remaining fifth passes through b, and about one-fourth of it gathers as liquid in the vacuum-jacketed vessel, C, at a pressure which is only so much above that of the atmosphere as will allow the liquid to pass out when the stopcock, h, is opened. The unliquefied or re-evaporated part of what has passed through b escapes through the outermost tube of the interchanger. The pump, e, takes in fresh air from the atmosphere, compresses it to 16 atmospheres' pressure, and delivers it so that it mixes with the air which is returning at that pressure from the middle tube of the interchanger to the pump, d. The compressed air, on leaving each pump, passes through a coil in a water cooler which also serves to jacket the pump. A small quantity of water is drawn in along with the air by the low pressure pump, and this, together with the natural moisture of the air, is extracted as completely as possible, first by means of a separator, f, and then by making the compressed air pass through a coil, g, in a bath of ice and salt before it goes into the interchanger. The interchanger is inclosed in a case packed with sheep's wool.

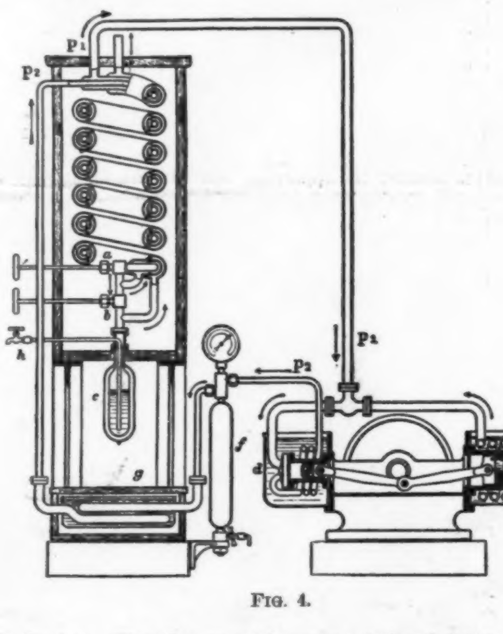


FIG. 4.

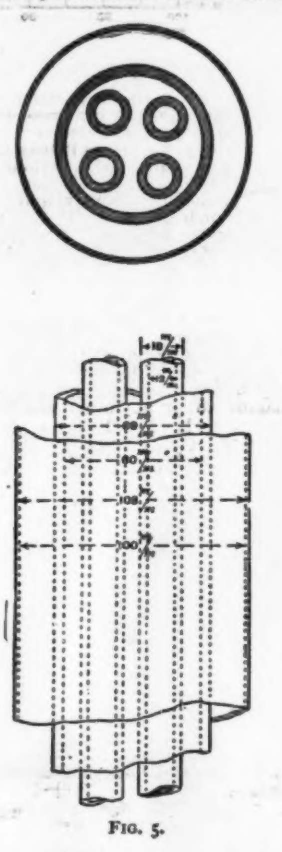


FIG. 5.

The admirable device of the open vacuum-jacketed vessel, which we owe to Prof. Dewar, enables liquid air to be decanted and handled with the greatest ease, to be conveyed from place to place, and to be stored during short periods with no more than a very moderate loss of evaporation.

The machine now exhibited circulates about 15 cubic meters of air per hour in the circuit from 200 atmospheres to 16 atmospheres. About three cubic meters per hour are pumped in from outside, and this is the amount which passes through the lower valve. I am informed by Dr. F. Linde that about 0·9 liter of liquid air are formed per hour, with a continuous expenditure of three horse power. Larger sizes of the machine are made, requiring five and seven horse power respectively. More than a dozen of these machines are now in use in various Continental laboratories.

Dr. Linde is now constructing a machine of 120 horse power for the Rhenania Chemical Works, at Aix-la-Chapelle, which is to be applied to the improvement of the Deacon process of chlorine manufacture. This machine is expected to produce 50 liters of liquid air per hour, or in round numbers, 1 lb. of liquid air per horse power hour. In the Deacon process, as ordinarily carried out, a mixture of hydrochloric acid with air is treated, and a mixture of chlorine with nitrogen is produced.

Dr. Linde's machine will serve two purposes, namely (1), to increase the efficiency of the process by substituting a gas rich in oxygen for atmospheric air in the first instance, and (2), after the treatment, to cause the chlorine to be separated as a liquid from the mixed product without compression, through the agency of cold. In this case the interchanger takes the form of one great spiral made up of an outer tube 100 millimeters in diameter, with an inner tube 60 mm. in diameter and 4⅛ mm. thick to convey back the air at p_1 (which is 50 atmospheres), and inside of that are four tubes, each 12 mm. in diameter and 3 mm. thick, for the high pressure air at 200 atmospheres (see Fig. 5). The tubes are all of copper.

Various further uses for the richly oxygenated atmosphere in metallurgical and other processes are under consideration. Furnaces and blowpipes in which combustion is sustained by the enriched air may be expected to find application for many purposes. Suggestions for other uses have been made, but have not yet gone far enough to be referred to in detail.

The most interesting application of the liquid which has hitherto been tried on a commercial scale is to make an explosive by mixing it with carbon. When liquid air, enriched by the evaporation of a large part of its nitrogen, is mixed with powdered charcoal, it forms an explosive comparable in power to dynamite, and which, like dynamite, can be made to go off violently by using a detonator. To make the explosive, Dr. Linde pours the liquid, containing about 40 or 50 per cent. of oxygen, on fragments of wood charcoal, two to four cubic millimeters in size. These are kept from scattering under the ebullition of the liquid by mixing them into a sort of sponge with about one-third of their weight of cotton wool. The liquid which remains is, of course, richer in oxygen than that which is originally applied, and when the mixture is allowed to stand for long all the liquid evaporates and the explosive power disappears. It must, therefore, be mixed at or near the place where it is to be used. But the cotton wadding impregnated with coarse charcoal powder can take up more than enough of the liquid to supply oxygen for its complete combustion, and when put quickly into thick insulating cases, made of paper, it retains its full explosive power for five or ten minutes. After an interval, which ranges from fifteen to thirty minutes, according to the size of the cartridge, all explosive power is lost. Experiments with the explosive were made on the parade ground at Munich, and a practical test on a large scale has gone on for some months in a coal mine at Pensberg, not far from Munich. The trials there were continued from July to October of last year and are claimed to have given very satisfactory results. The chief advantage of the explosive is its cheapness, the cost being to all intents and purposes simply that of the power used in liquefying the air. Even the fact that after a short time the mixture ceases to be capable of exploding may be urged as a recommendation in one respect, for if a detonator hangs fire there is no danger of the charge going off accidentally some time after the explosion is due; nor is there any risk of its being purloined or used for criminal purposes. On the other hand, it is obvious that this explosive would be neither convenient nor economical, except in cases where a large amount of blasting is to be done at or about one place, and during a long period of time. A great stone quarry or slate quarry, or an engineering work such as the cutting of an Alpine tunnel, would appear to offer a likely field for its application.

In the trials made at Pensberg the machine used was of the type now exhibited and shown in Fig. 4, but large enough to produce 3 liters of the liquid per hour. The liquid as withdrawn from such a machine contains from 35 to 40 per cent. of oxygen, and is sufficiently rich to be used for making the explosive, with no more than the further strengthening which it necessarily gets through evaporation in the processes of transport and mixing.

By using a liquid containing more or less nitrogen in the filling of the cartridges the strength of the explosion is under some control, and it is suggested that the temperature may in this way be kept down sufficiently to minimize the risk of igniting fire damp and coal dust in mines.

With a machine in constant use Dr. Linde obtains from 0·4 to 0·5 liter of a liquid containing 50 per cent. of oxygen per horse power hour. If we assume that up to the instant of explosion two-thirds of the liquid has been evaporated, which raises the proportion of oxygen to 80 per cent., then 4 to 5 horse power hours are used in producing 1 kilogramme of explosive material. Beyond this there is the cost of the wrapping, the cotton wool, and the charcoal powder. But these items are inconsiderable.

AMATEUR PLASTER CASTS.

THE art of plaster casting is so simple that with a little patience any one may acquire it and get the most pleasing results. It is an inexpensive amusement, says The New York Sun. The plaster costs only a dollar a barrel, and enough may be had for 25 cents to last the most enthusiastic amateur for months. For the beginner, who is not accustomed to the freaks of plaster, it is better to experiment on a cast before attempting to do anything from life. A bass relief is the best thing to practice on.

The first thing to consider in making a cast of a hand is to have the hand to be experimented with in the best possible condition. The nails should be carefully shaped and the cuticle pressed into place. The hand should be washed in warm water so that the muscles become relaxed and the fingers supple, and the cold tap run over it long enough to close the pores; rub the hand and as far up the arm as the cast is to be taken with glycerine. This will prevent the plaster from sticking. Great care should be taken not to let the glycerine escape any part. It should be brushed under the finger nails with a small camel's hair brush.

The next and most important thing is the mixing of the plaster. For this take a large bowl and pour the water into it; then sprinkle the plaster in until it reaches the surface of the water. Stir briskly until the whole is of a uniform consistency. It must not, however, be stirred too long or the plaster loses its nature and will not harden. When it is first mixed, the plaster should be like very thick cream.

The hand upon which the glycerine has been rubbed is then laid carelessly and naturally upon a piece of old sheeting or a soft towel which is dropped upon the table, and allowed to assume its natural pose. Then the plaster should be taken out in a small teacup and poured over the hand in as thin a coat as possible at first. So that no air bubbles may remain, the caster should blow the plaster until every bit of air has escaped. After the hand is well covered with the first coat, the rest of the plaster should be added quickly and evenly distributed until the cast is about two inches thick. The hand should be kept perfectly quiet until the plaster has set. This takes about fifteen minutes. As soon as the hand begins to feel the heat of the plaster, it should be carefully lifted up by the caster and turned over. Then all the little bits of plaster which have leaked through between the fingers should be broken away by the caster. Sometimes a dull tool, such as a stonecutter's chisel, is of much assistance, and it must be remembered that all the patience of the caster and the sitter are required to remove the hand without injury to the mould.

After the plaster has had ten or fifteen minutes in which to set, the sitter may begin to wriggle and gradually work the fingers without doing harm to the cast, and though the hand appears to be firmly embedded in the plaster it will soon be felt to be breaking away if the muscles of the fingers are firmly stretched backward and forward.

Once the hand is free, the cast must be placed where it will dry slowly. It should not be touched for two or three days. Before the cast is made the mould should be washed out with boiled oil and soap. This should be applied with a soft brush which will not injure the fine lines in the mould. After the plaster has set for the second time the outer covering can be gently chipped out by blunt stonecutter's chisel and a hammer. This destroys the mould, but should leave the cast perfect.

To mount the hand, fill a small oblong tray which has been well rinsed with either glycerine or boiled oil with plaster of Paris, and before it is quite hard place the hand on the plaster so that the finger tips, wrist and palm just become embedded enough to adhere.

Should the caster be more ambitious and desire to cast the hand in the round, there are more problems to be dealt with. Fill a tray with plaster and allow it to become half settled. Then immerse the hand, which must have been covered with glycerine beforehand, until the palm is half embedded in the plaster; let the plaster set until it is perfectly hard, and, with a soft

brush, cover the surface of the plaster all in between the fingers and up about the wrists with boiled oil and soap; then cover the hand first with thin plaster—not forgetting to blow out the bubbles—and then with the thicker.

As soon as the hand begins to feel hot, the plaster is well set. The upper covering can be removed and the hand lifted out. There are then two moulds, one of the palm of the hand and one of the back. When these are dry they must be brushed carefully with boiled oil and soap and tied firmly together, care being taken that the back of the fingers match evenly with the front.

There should be no hole visible excepting at the wrist, but in case there are any little cracks down the sides of the fingers, where the moulds come together, they may be filled with bits of beeswax or gray clay.

The mould is now ready for the plaster, which should be poured in at the wrist, quite thin at first, so that it may readily be washed round and round until it hardens in a thick crust on the inside; gradually more and thicker plaster should be applied until the cast is solid. When it is set, the moulds can be easily separated, and the cast should be allowed to dry. A little loop made out of iron wire and inserted before the plaster is set enables it to be hung upon the wall.

The casting of the face is more difficult than the casting of the hand, if it is done in the proper way. It is most simple to have the sitters lie on their back, with a low cushion under the head. Great care should be taken in glycerining the face, particularly the eyelids. The eyebrows should be covered with a thin coating of clay, and a mustache should be built out with clay, modeled in just the form in which it grows, and then glycerined. A towel should be placed far back under the chin, brought round the front of the ears, and fastened firmly over the top of the forehead, just where the hair begins. Small pieces of wax or clay should be inserted in the nostrils, through which the sitter draws breath. This allows the lips to be kept naturally closed while the mould is being taken of the mouth.

Before the plaster is applied it is most essential that the caster explain to the sitter that after the plaster has been applied he will become conscious of the feeling that it is going to fall off the face. Many a cast has been spoiled by the movement of the muscles of sitters in their efforts to explain that the plaster is about to fall away from the face. This sensation is caused by its hardening, and is a false alarm.

The first coat of plaster applied to the face should be very thin and put on with a brush. It must be daubed rather than painted over until the features are covered with a coat about an eighth of an inch thick, then carefully, and with as little pressure on the muscles as is possible, the plaster should be applied until it is an inch and a half or two inches in thickness, and as soon as it has set it can readily be lifted from the face. Almost any number of casts can be made if the mould proves good.

POLISHING MARBLE.

POLISHING includes five operations. Smoothing the roughness left on the surface is done by rubbing the marble with a piece of moist sandstone; for mouldings either wooden or iron mullers are used, crushed and wet sandstone, or sand, more or less fine, according to the degree of polish required, being thrown under them. The second process is continued rubbing with pieces of pottery without enamel, which have only been baked once, also wet. If a brilliant polish is required, Gothland stone instead of pottery is used, and potter's clay or fuller's earth is placed beneath the muller. This operation is performed upon granites and porphyry with emery and a lead muller, the upper part of which is incrusted with the mixture until reduced by friction to clay or impalpable powder. As the polish depends almost entirely upon these two operations, care must be taken that they are performed with a regular and steady movement. When the marble has received the first polish, the flaws, cavities, and soft spots are sought out and filled with mastic of a suitable color. This mastic is usually composed of a mixture of yellow wax, resin and Burgundy pitch, mixed with a little sulphur and plaster passed through a fine sieve, which gives it the consistency of a thick paste; to color this paste to a tone analogous to the ground tints or natural cement of the material upon which it is placed, lampblack and rouge, with a little of the prevailing color of the material, are added. For green and red marbles, this mastic is sometimes made of gum lac, mixed with Spanish sealing wax of the color of the marble. It is applied with pincers, and these parts are polished with the rest. Sometimes crushed fragments of the marble worked are introduced into the cement, but for fine marbles the same colors are employed which are used in painting, and which will produce the same tone as the ground; the gum lac is added to give it body and brilliancy. The third operation in polishing consists in rubbing it again with a hard pumice stone, under which water is being constantly poured, unmixed with sand. For the fourth process, called softening the ground, lead filings are mixed with the emery mud produced by the polishing of mirrors or the working of precious stones, and the marble is rubbed by a compact linen cushion well saturated with this mixture; rouge is also used for this polish. For some outside works, and for hearths and paving tiles, marble workers confine themselves to this polish. When the marbles have holes or grains, a lead muller is substituted for the linen cushion. In order to give a perfect brilliancy to the polish, the gloss is applied. Well wash the prepared surfaces and leave them until perfectly dry, then take a linen cushion, moistened only with water, and a little powder of calcined tin of the first quality. After rubbing with this for some time, take another cushion of dry rags, rub with it lightly, brush away any foreign substance which might scratch the marble, and a perfect polish will be obtained. A little alum mixed with the water used penetrates the pores of the marble, and gives it a speedier polish. This polish spots very easily and is soon tarnished and destroyed by dampness. It is necessary when purchasing articles of polished marbles to subject them to the test of water; if there is too much alum, the marble absorbs the water and a whitish spot is left.—Stonemason.

LITTLE'S CONTINUOUS RECORDING INDICATOR.

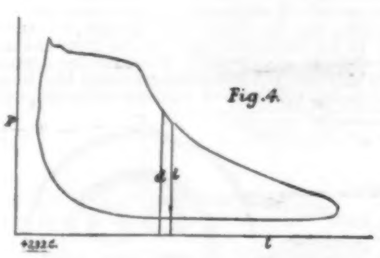
NUMEROUS attempts have been made from time to time to devise an instrument capable of integrating continuously the work done in the cylinder of an engine under all conditions of varying load, as it was evident that such an instrument would do for the steam engine what the recording wattmeter has done for the dynamo.

The following is a description of an indicator invented by Mr. W. G. Little and Mr. C. W. G. Little, of Bexley, Kent (and manufactured by the former), which has been designed to meet these requirements.

In this instrument the principle of the planimeter is

FIG. 2.

FIG. 3.



taken advantage of to produce a continuous record upon a counter which is actuated directly by the axis of the wheel of the planimeter itself, and which is so constructed that it may be run for a length of time, even at high speeds, without observation. The action of the instrument is virtually that of a planimeter, in which the inclination of the planimeter wheel is produced by the varying pressures of steam on the indicator piston, and in such a way that the amount of rotation of the wheel is proportional to the steam pressure producing such inclination. The instrument may be regarded as a planimeter, in which the wheel is fixed, and turning on its edge, takes those inclinations which would be imparted to it in the ordinary way by tracing the pointer round a diagram, while the diagram card in contact with it is reciprocated through a distance equal to the length of the diagram. As the inclination of the planimeter wheel, when tracing a

LITTLE'S CONTINUOUS RECORDING INDICATOR.

diagram, is produced by a combination of vertical and horizontal motions of the tracing pointer, so in this instrument the proper amount of inclination of the wheel is imparted to it by a sine motion, produced by a slot and pin, as shown in Fig. 1.

With reference to Fig. 1 the following is a description of the details of the instrument. A is the cylinder of the indicator containing the piston and spring, which are of the usual standard type. B is a carriage, sliding on to the upper part of the cylinder, and securely held in position upon the bracket of the instrument by the conical screw, G, which, on being screwed home, brings the axis of the shaft, C, into a position to cut the axis of the drum, O, at right angles. C is a shaft provided with a rigid arm, P, carrying the counter, F, and one pivot of the axis of the wheel, E, the other end of which is pivoted on the shaft itself. The wheel, E, is dished to allow of the forward bearing, H, being brought close up to the contact slide, L, of the drum, O, and in line with the shaft, C. The counter, F, consists of two toothed wheels, one of 100 teeth and the other of 99 teeth, both engaging with a worm on the axis of the planimeter wheel, the upper one being graduated in 100 divisions, a simple and well known device for recording a large number of revolutions. D is a crank carrying a pin, I, working in the slot of the crosshead, R (Fig. 2), which pin is kept in contact with the lower surface of the slot by means of the small spring, S. The spring, I, bears upon the pointed end of the shaft, keeping the wheel in contact with the drum at a fixed pressure. M is a rocker enabling the wheel to be placed in contact with the drum or not at will. K is a frame carrying the bearings of the drum, O, the latter being provided with a hollow spindle which can be filled with oil for the lubrication of the upper and lower bearings, which are conical centers. The lower part of the frame is split, and, fitting accurately over the spring box on the bracket, can be tightened up in any desired position by means of a single screw. The milled head, T, is a removable stop to the drum, O. M is a device for accurately measuring the stroke of the drum while in motion, and which, by means of a vernier, can be read to $\frac{1}{200}$ inch. The details of this are shown in Fig. 3, from which it will be seen that the device consists of three parts, a center piece attached to the frame, and two rings fitting around it, each being provided with a tooth on the lower side, one ring being graduated, the other carrying a vernier. As the upper edge of the drum is provided with a similar tooth at the same distance from the center, its contact with those on the rings causes them to set themselves apart by an amount equal to the stroke of the drum and thus to record accurately the amount of its rotation. L is a hard brass sleeve which can be slid up or down, allowing a change of the contact surface if necessary; but as the pressure of the wheel upon the slide is very slight, a great number of revolutions can be made upon one place before the line of contact can be detected even by the finger nail, and the instrument will continue to record accurately for an indefinite length of time.

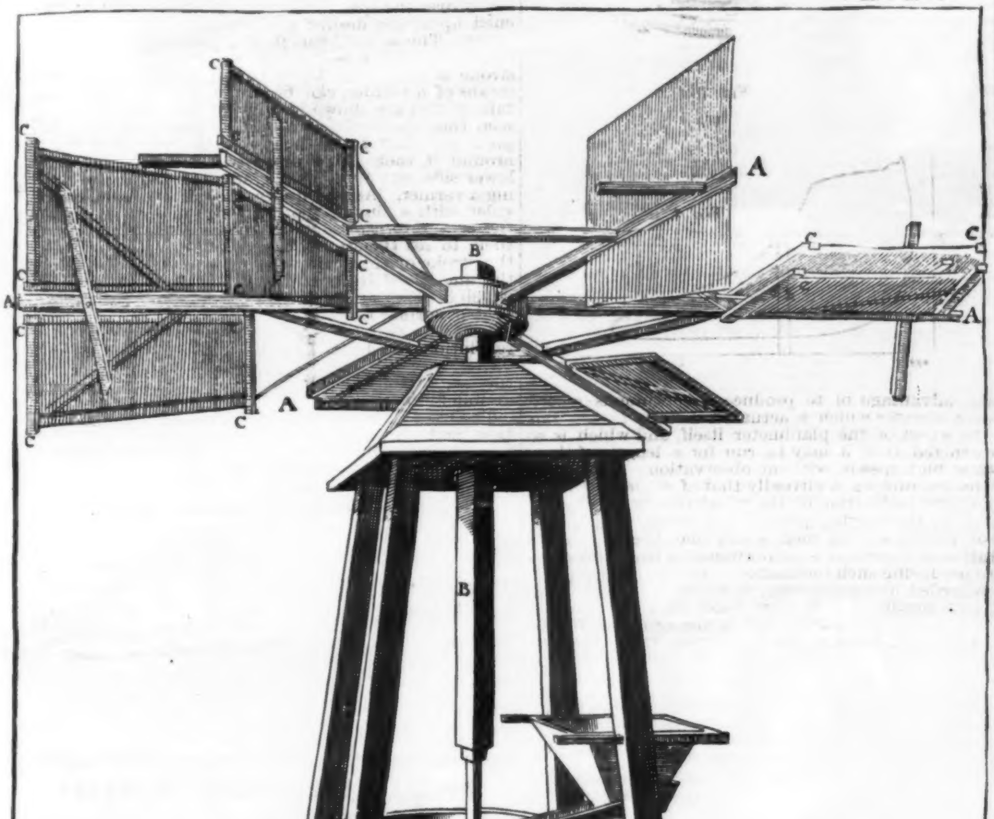
The use of an instrument of this kind not only saves time and prevents the errors inseparable from the measuring up of a quantity of diagrams, but enables tests of steam consumption to be made under actual working conditions of varying load during considerable lengths of time, a matter of impossibility with a diagram indicator except on absolutely constant loads—an ideal condition unattainable in practice.—Engineering.

ARTICULATED LOCOMOTIVES.

ARTICULATED locomotives on the Haggans system have been built by F. Weidknecht, of Paris, for service on the Volo & Lechonia Ry., in Thessaly. The railway has a gage of 24 inches with steep grades and sharp curves. The locomotives are tank engines, with a rear pair of coupled axles carried in the main frame of the engine, and the front pair of coupled axles carried in a swiveling truck frame. On each side, above the frame, is a horizontal cylinder whose connecting rod drives a vertical rocker arm, to the lower end of which is attached the connecting rod which drives the leading axle of the rear pair. A coupling rod on the rocker drives a second rocker which carries a connecting rod driving the rear axle of the front pair. To allow of the swiveling of the truck, ball and socket joints are required for some of the rods. There are seven rods and two rockers on each side exclusive of the rods of a mod-

ified form of Walschaert valve gear. In our issue of February 9, 1893, we described the Cowles articulated locomotive, which had two driving trucks, with a single pair of horizontal cylinders mounted on the middle of the frame, and having piston rods through both ends of the cylinders. The four connecting rods drove two crank axles journaled in the main frame, each of these axles passing through the hollow axle of the main pair of drivers, the inner and outer axles being connected at the middle by a universal joint. The hollow axle was large enough to allow it to follow the radiating movement of the truck on curves without striking the interior rigid axle. Annular crank arms on the hollow axles carried the ends of the coupling rods. We have several times had occasion to refer to the complications of mechanism with which foreign locomotive builders are fond of encumbering their engines, and our views are indorsed by The Engineer, of London, in its remarks on the Haggans engine, as follows:

"All this is exceedingly ingenious and beautiful, and we take the word of our contemporary (Portefeuille Economique des Machines) for it that the system works well. It is certainly one to delight the heart of a Frenchman. Just look at the number of moving parts, of joints to be oiled, of traps for dirt! Consider the joy of seeing it all going together, of working the brakes, the injectors, the whistle, the reversing gear all at the same time, and oh! climax, paragon, zenith of delight, to be able to do it all going round a curve of thirty meters with a load of sixty tons behind you, and la mère waiting for you at the corner!"—Engineering News.



WINDMILL.

WINDMILL.

WHAT is troublesome in most windmills is to present their fans to the quarter whence the wind comes, and, as winds often change direction, the operation is somewhat burdensome. But this may be remedied by the manner in which the mill here figured is constructed, since the fans never change arrangement, and are so made that they revolve in every wind.

The fans of this mill, which are marked A, are all placed horizontally upon the perpendicular axis, B, and the canvas of each is kept taut by frames, C, to which they are attached by a hinge in such a way that they can open or close, or, in other words, so that, by their perpendicular or horizontal arrangement, they can resist the wind or cede to it.

It will be easily understood from the figure that from whatever quarter the wind comes, the construction of the fans is such that the wind makes them open or close, according as it is necessary that they shall resist or cede in order to cause the machine to revolve.

It is also easy to see how the fans, A, thrust by the wind, cause the millstones to revolve, since the latter and the fans have one axis in common, so that both have to revolve together.—From Recueil d'Ouvrages Curieux de Mathematique et de Mecanique, 1733.

LOCOMOTIVE "SPARKS" AS FUEL.

FROM official sources some interesting and suggestive facts are learned here as to the results of the use as fuel in the electric power houses of the New Haven Railroad Company of the small, partly burned cinders, known as "sparks," obtained by the use of spark arresters on the steam locomotives of the company.

The tests of these sparks have already passed far beyond the limbo of experiment, says The Evening Post, and the economy of the new use of what has hitherto been deemed a waste product only to be used for filling on the tracks is considered demonstrated. At the Stamford electric power house they have been used exclusively as fuel for almost eleven months, or ever since last November, and at the Nantasket and Berlin power houses about two months. At the other power house of the company, in Meriden, they have not yet been tested, as the furnaces have not been adapted to the new fuel.

Figures carefully compiled and compared for the Stamford power house during the eleven months give a cost of three mills per horse power hour for sparks with an engine running at unequal "loads." A test made with an engine running with normal load gave a cost per horse power hour of three and two-tenths mills for coal (soft) and one and nine-tenths mills for sparks. At the Nantasket power station, running the engine with variable loads, the cost has been four and two-tenths mills for coal, two and two-tenths mills for sparks. At the Berlin power station, which operates the third rail between that place and New Britain, and for about ten miles between the latter city and Hartford, with the engine running at about one-third the normal load, the figures have been six mills for coal and three mills for sparks. The figures are based upon a cost at the power stations of $3 per ton for coal and seventy-two cents a ton for sparks, two tons of the latter being about equal in heat efficiency to one ton of coal. The Stamford power station has consumed about eighteen tons of sparks per day.

The use of the sparks requires a special draught, but old furnaces can be differently set, and, as a rule, adapted to the new fuel, which is fed in like coal, and makes a hot and very ebullient fire. The product of sparks on the whole New Haven system, with about 3,008 miles of single track and 710 locomotives, is said to be enough to supply fuel to several new electric power houses, in addition to the four already operated. A careful analysis is to be made by the company of the sparks, which consist largely of carbon.

THE MINERALS AND METALS OF THE UNITED STATES.

IF there is one thing more than another respecting which, from an industrial point of view, it is desirable—or rather, necessary—for a country to possess a correct detailed record, it is unquestionably its mineral resources and metallic products. And if there is one country more than another where this record is carried out exhaustively and to perfection, that country is the United States, as testified by the thirteenth annual report on the mineral resources of the country for 1896, an advance copy of which we have just received from Dr. David T. Day, who has had charge of its production. Some idea of the extent of the information afforded and of the labor involved in the production of the volume may be gathered from the fact that it comprises no fewer than 1,400 pages, bristling with figures and containing information which is simply invaluable. As a matter of course it ranges over a wide field, for the mineral resources and the metallic products of the United States are both extensive and numerous. The report comprises a series of exhaustive and highly interesting papers by experts in the subjects dealt with, and whose names are given, the method of obtaining the information being that of a census of each industry. The statistics of the production of gold and silver are, as usual, those of the director of the mint, which are accepted as official. The statistics of the imports and exports are obtained through the chief of the Bureau of Statistics of the Treasury Department.

The first feature of the report is a comparative summary prepared by Dr. Day himself, but as we purpose dealing with the leading features of the report seriatim we shall only here refer to the totals as given by Dr. Day. And here we find that, instead of a normal increase of at least $25,000,000, the mineral product of 1896 showed only a slight increase in its total value from $622,628,685 in 1895 to $623,717,288 in 1896. There were nine substances of which the product was not only increased, but for which the value was the greatest ever attained. Among these the most important were gold, copper, aluminum and petroleum. On the other hand, the product of many substances was increased in amount, but the value was less than that of the smaller product yielded the year before. This includes such important substances as lead, bituminous coal, building stones, mineral waters, salt and pyrites. During the whole of 1896 there was a serious reaction from the activity of 1895 in all branches of the iron and steel industries of the United States, except in open-hearth steel. On the other hand, the gold product was valued at $53,088,000, which was not only the greatest ever obtained in the United States, but was a percentage of 12¼ over 1895 and more than 25⅙ over 1894. The coining value of the silver product was $76,069,236, being an increase of $4,018,236 over 1895. The copper industry flourished, the product being 460,061,430 pounds, valued at $49,456,603, the greatest product ever obtained in the United States. Lead and zinc showed a decline, as did also quicksilver, although in the latter case not a material one. Aluminum, antimony, nickel and manganese showed an increase, particularly the first named metal. There was a slight decline in coal and coke, but an increase in petroleum and a decline in natural gas. An interesting feature in the coke industry of 1896 was the increase in value; for, while the production was less than in 1895, the value increased by $2,426,410.

Turning to the report, which was furnished by Mr. John Birkinbine, on iron ores, we find that that industry felt severely the continued commercial depression. During 1896 there were fewer producing mines than in previous years, but the total output was above the average. Twenty-three States contributed to the production of 16,005,449 long tons for the United States in 1896, as compared with 15,957,614 in 1895. So many mines were idle, and the managers absent, that the collection of statistics was extraordinarily difficult. This refers mainly to smaller mines, although the aggregate production even of these is important from a statistical point of view. From a tabulated statement showing the production of the various classes of iron ore in 1896 it appears that the output of the red hematite variety aggregated 12,576,288 long tons, or 78·58 per cent. of the total output, as against 12,513,995 tons or 78·42 per cent. in 1895. The percentage of brown hematite was also greater, rising from 2,102,358 long tons or 13·17 per cent. in 1895 to 2,126,212 long tons or 13·28 per cent. in 1896. There was, however, a falling off in the magnetite class, only 1,211,526 long tons or 7·57 per cent. being produced in 1896, as compared with 1,268,222 long tons or 7·95 per cent. in 1895. The carbonate variety also increased from 73,039 long tons or 0·46 per cent. in 1895 to 91,423 long tons or 0·57 per cent. in 1896. It will thus be seen that the amounts and approximate proportions of red and brown hematite and carbonate ores were greater in 1896 than 1895, the magnetic ores alone showing a decline. The total amount produced, namely, 16,005,449 long tons, is 47,835 long tons, or 0·30 per cent. greater than the output in 1895, namely 15,957,614 long tons. In the total is also included iron ores, which carry manganese varying from 3·1 to 35 per cent., amounting to 467,719 long tons. In 1896 44,953 long tons of franklinite residuum, valued at $20,455 or 46 cents per ton, were produced. The total amount of concentrates obtained by treating lean or impure iron ores in that year was 53,717 long tons.

The great iron-producing region of the United States is that of Lake Superior. The entire product of Michigan, of Minnesota, and of Wisconsin (except some fossil ores mined in the eastern central portion of Wisconsin) was obtained from what is generally considered the Lake Superior district. All the ores were marketed as Lake Superior ores, and were designated by various characteristics, such as specular, magnetic, hematite, hard or soft, or by the names of specific mines. The quantity of Lake Superior ores produced in 1896 reach-

ed a total of 10,566,359 long tons, valued at the mines at an average of $1.57 per long ton. Compared with the production of previous years, this is the largest reported. The bulk of the Lake Superior ores is sent to one dock on the upper lake by local railways, and the freight charges for such transport in 1896 amounted to over $6,000,000. From the ore docks the ore is carried by vessels to receiving docks on the lower lakes. The cost for water transport for the above named year approximated to the aggregate railway freights from the mines to the shipping docks. The market prices for these ores are based upon delivery at the lower lake receiving docks, and in addition, consumers pay transport from these receiving docks to blast furnaces in various States, a drawback being allowed on ores which are forwarded to the furnaces direct from the vessel without being stored in the dock. The average rail and water haulage of Lake Superior ores between the mines producing them and the blast furnaces smelting them is approximately 800 miles. Of the total Lake Superior product in 1896, Michigan supplied 54·01 per cent., Minnesota 40·54 per cent. and Wisconsin 5·45 per cent.

As an iron ore producer Michigan stands first, as she has done in previous years, the production for 1896 being 5,706,736 long tons, as against 5,812,444 tons in 1895. This is equivalent to 35·65 per cent. of the total for the United States, and indicates a decline of 1·82 per cent. on the previous year. Of this output 5,635,997 long tons was red hematite, giving Michigan the first position as a producer of that character of ore; 70,739 tons of the product was magnetite. Minnesota continues to hold the second place as a producer of iron ore. She shows an output of 4,283,800 long tons in 1896, or 26·77 per cent. of the total for the United States. This shows an increase of 417,427 long tons or 10·80 per cent. over the production of that State for 1895, which was 3,866,453 tons. All the iron was of the red hematite class, and in this variety Minnesota also ranked second. Alabama is noted for producing large quantities of iron ores at a low cost; but as they are not of Bessemer grade, they are used chiefly in the manufacture of foundry iron. That State held third rank as a producer in 1896, having an output of 2,041,793 long tons of iron ore, of which 1,694,948 tons was red hematite and 346,845 tons brown hematite. This total shows a decline of 157,597 tons, or 7·17 per cent. on the output of 1895, which was 2,199,390 long tons. The output for Pennsylvania in 1896 amounted to 747,784 long tons, a decline of 152,556 tons, or 16·94 per cent. upon that of 1895, which was 900,340 tons. All of the four general varieties of iron ore were produced. The ore raised in Wisconsin was all of the red hematite variety, the quantity being 607,405 long tons, which was 41,946 tons or 6·46 per cent. less than the product of 1895, which was 649,351 tons. As already observed, most of the iron ore is mined in the Lake Superior region. Tennessee produced a total of 535,484 long tons of brown and red hematite and carbonate ore, being an increase of 15,688 tons or 3·02 per cent. on the production of 1895, which was 519,796 tons. New York State, like Pennsylvania, mined all four classes of iron ore, the total for the year being 385,477 long tons, an advance of 78,221 tons or 25·46 per cent. over the total of 307,256 tons for 1895. New Jersey produced only 264,999 long tons of ore, which is a decrease of 17,434 tons, or 6·17 per cent. on the total of 1895, which was 282,433 tons.

Besides the iron ore which is smelted in the blast furnaces in Colorado for the production of pig iron, considerable quantities of argentiferous iron ores and manganiferous iron ores are utilized as fluxes in smelting the precious metals and for the manufacture of spiegeleisen or ferro-manganese. As a number of the silver smelting works were closed in 1896, and as mining operations in the important district of Leadville were interfered with by a disastrous and extended strike, the production for 1896 was only 215,819 long tons, a decline upon the previous year of 10·43 per cent., the 1895 output having been 240,937 tons. The total output of Ohio was 58,480 tons, the ore being entirely of the carbonate variety, in which class this State occupied first place.

In the Western States and Territories the iron ore produced was used as a flux in smelting. Kentucky, like the Eastern States, felt the keen competition from Michigan and Minnesota, and showed a decreased output in 1896. The brown hematites of Connecticut and Massachusetts are used in the local blast furnaces, and as most of these were inactive during a portion of the year owing to the decreased pig iron production, the iron ore exploitation showed a corresponding decline. In Maryland carbonate ores are used in the production of special grades of pig iron in local furnaces, and Texas utilizes a small amount of brown hematite in the manufacture of charcoal pig iron. Missouri, which was formerly a prominent iron ore producer, has fallen to the bottom of the list, owing to the exhaustion of the red hematite deposits, and the use of richer Lake Superior ore at the blast furnaces on the Ohio and Mississippi Rivers. The small amount of brown hematite mined was used as a flux in smelting. The total iron ore production of the United States in 1896, namely 16,005,449 long tons, was valued at $22,788,069 at the mines, or $1.42 per ton. This was an increase on the average value per ton in 1895 ($1.14) of 28 cents per ton, or 24·56 per cent.—Perry F. Nursey in Industries and Iron.

FILTRATION OF MILK.

IN several European cities sand filtration of milk is employed at a central depot after its arrival from the country. The filters consist of large cylindrical vessels, divided by horizontal superposed compartments, of which the middle three are filled with fine clean sand, sifted into three sizes, the coarsest being placed in the lowest and the finest in the topmost of the three compartments. The milk enters the lowest compartment through a pipe under gravitation pressure, and, after having traversed the layers of sand from below upward, is carried by an overflow to a cooler fed with ice water, whence it passes into a cistern, from which it is directly drawn into locked cans for distribution. Milk thus treated is not only free from dirt, but the number of bacteria is reduced to about one-third. In new milk the loss of fat is said to be very slight, but the quantity of mucus and slimy matter retained in the sand is surprising. The sand is renewed each time the filter is used.—Medical News.

THE
Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.